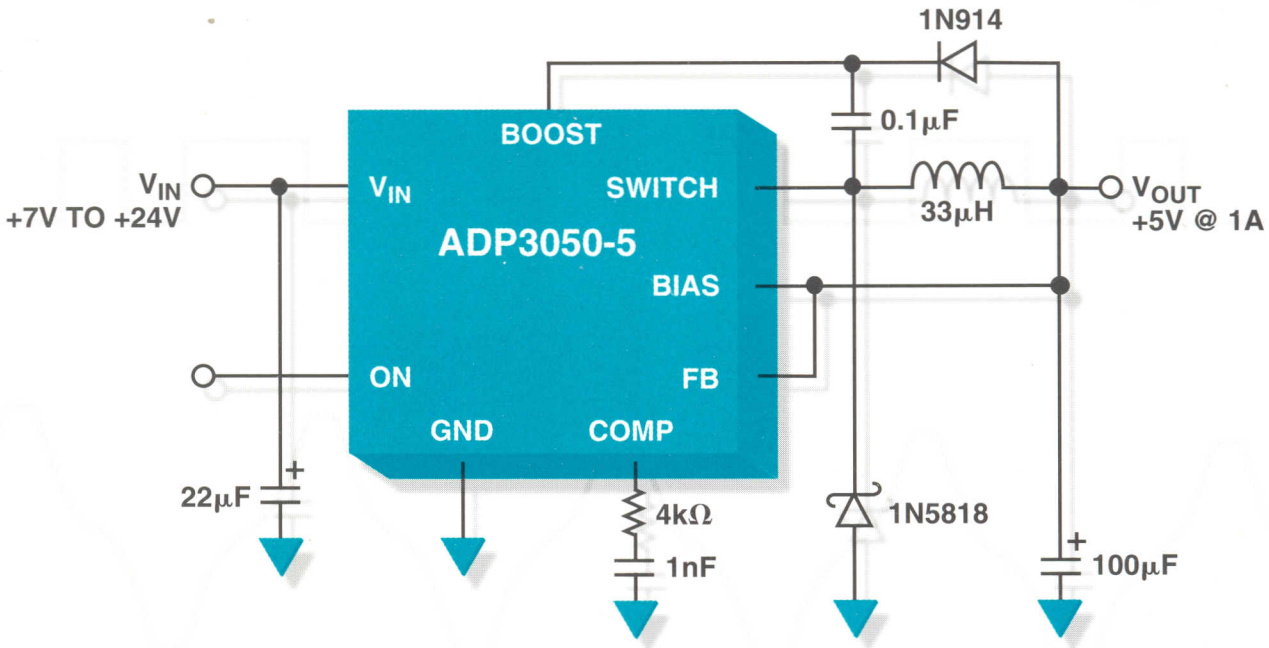
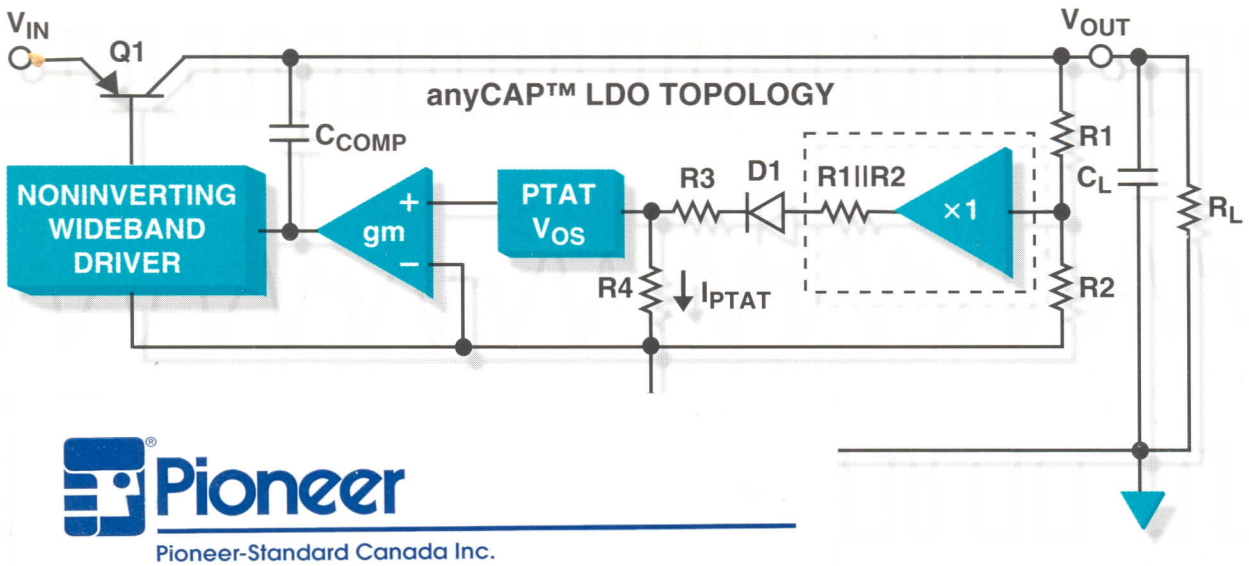
NEW PRODUCT APPLICATIONS – 1998

spring edition



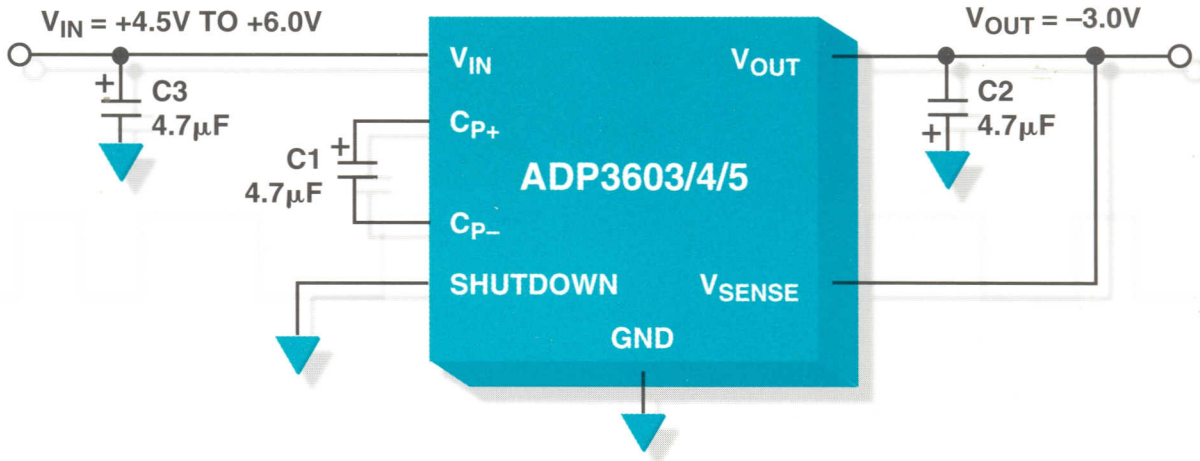


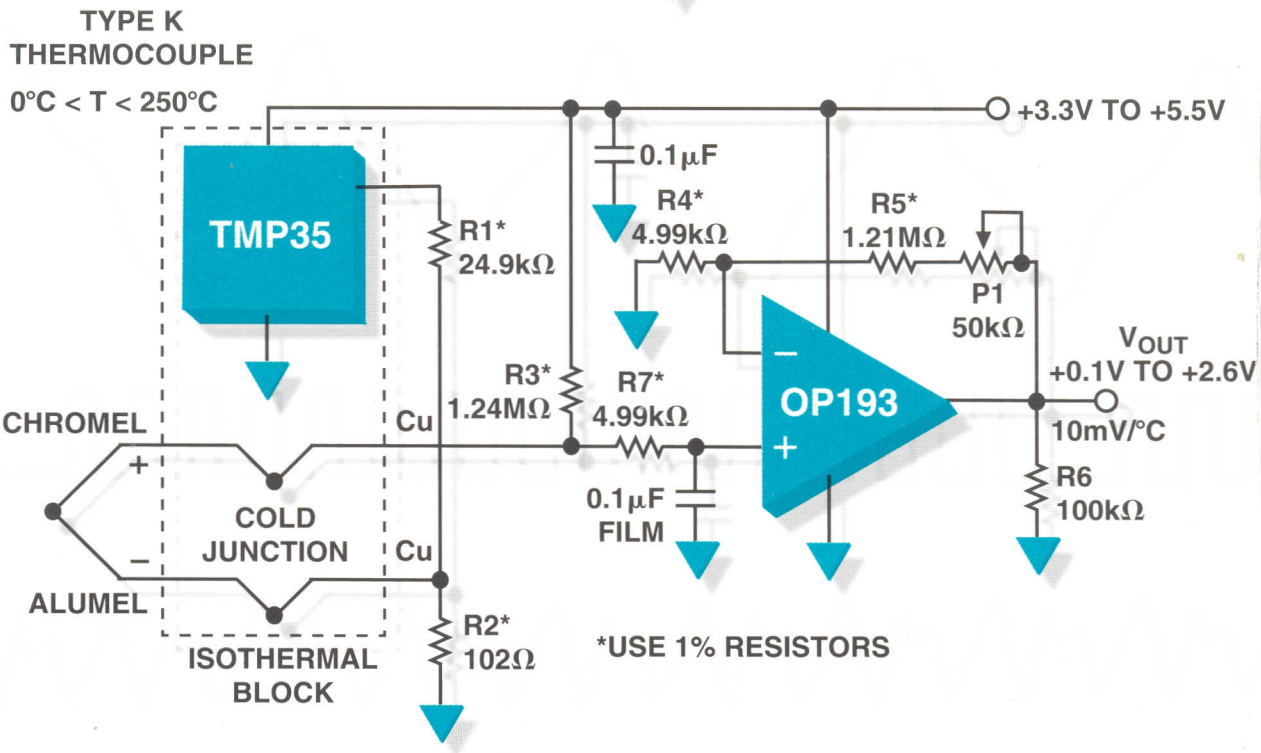
Pioneer

Pioneer-Standard Canada Inc.

3415 American Drive
Mississauga, Ontario L4V 1T4
Tel: 1-800-668-5642 Fax: (905) 405-6413

ANALOG DEVICES





ANALOG DEVICES

WORLDWIDE HEADQUARTERS
One Technology Way, P.O. Box 9106
Norwood, MA 02062-9106, U.S.A.
Tel: (781) 329-4700, Fax: (781) 326-8703

Printed in U.S.A.
E3305-10-3/98

NEW PRODUCT APPLICATIONS – 1998

spring edition

© Analog Devices, Inc., 1998
All Rights Reserved

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 1 - AMPLIFIERS

Model/Topic	Page No
High Speed, Voltage and Current Feedback Amplifiers	**1-3**
X.F.C.B. (Extra Fast Complementary Bipolar)	1-4
High Speed Current Feedback Amplifiers	**1-7**
AD8010 230 MHz, High Current Output Video Amplifier	1-8
AD8012 Dual Current Feedback Amplifier	1-10
AD8023 Low Cost, Triple Video Amplifier	1-11
AD8079 Fixed Gain, Dual 260 MHz Buffer	1-12
High Speed Voltage Feedback and Rail-Rail Amplifiers	**1-13**
What is a Rail-Rail Amplifier?	1-14
Why Rail-Rail?	1-17
AD8055 and AD8056 300 MHz, Low Cost Voltage Feedback Amplifiers	1-18
AD8051 and AD8052 110 MHz, Single/Dual Rail-Rail Voltage Feedback Amplifiers	1-19
AD8054 150 MHz, Quad Rail-Rail Voltage Feedback Amplifier	1-20
Precision, Low Power Amplifiers	**1-23**
AD8551*/8552*/8554* "Zero Drift" Chopper Amplifiers	1-24
OP181/281/481 and OP186* Single/Dual/Quad Micropower Amplifiers	1-25
OP250/450 2 MHz, CMOS Rail-Rail Amplifiers	**1-26**
AD8026* High Speed Quad Amplifier	1-27
LCD Display Signal Chain	1-28
AD8509 and AD8511 9 and 11 Channel LCD Reference Drivers	1-29
AD824* 2 MHz, Quad Rail-Rail FET Input Amplifier	1-31
High Speed Comparators	**1-33**
AD8561* and AD8564* 6 ns Single and Quad Comparators	1-34
Instrumentation Amplifiers	**1-37**
A Discrete Instrumentation Amp Using Rail-Rail Op Amps	1-43
AD627* Micropower, Rail-Rail Instrumentation Amplifier	1-46
AD623 Wideband, Low Cost, Rail-Rail Instrumentation Amplifier	1-47

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 2 - ANALOG SIGNAL PROCESSING

Model/Topic	Page No
Variable Gain (Time Gain) Amplifiers	**2-3**
What is Time Gain Amplification?	2-4
AD8320 Digitally Controlled VGA	2-5
AD8325* Fast Switching Digitally Controlled VGA	2-8
Log Amplifiers	**2-9**
AD8306* 350 MHz, 95 dB Demodulating Log Amp with Limiter	2-11
AD8307 Low Cost , 95 dB RSSI Log Amp	2-12
AD8309* Low Cost, 95 dB RSSI Log Amp with Limiter	2-13
RGB to NTSC/PAL Analog Encoders	**2-15**
AD725* Very Low Cost RGB to NTSC/PAL Encoder	2-16
Special Application Circuits	**2-18**
AD8390* AV Bus Driver Device	2-19
What is AVBus?	2-21
AD8313 0.1 to 2.4 GHz Power Detector	2-23

SECTION 3 - ANALOG TO DIGITAL CONVERTERS

Model/Topic	Page No
High Speed A/D Converters	**3-3**
What is a "Pipelined" A/D Converter?	3-4
8-10 Bit High Speed A/D Converters	**3-9**
AD9054 8 Bit, 135/200 MSPS A/D Converter	3-10
AD9483* Triple 8 Bit, 135 MSPS A/D Converter	3-11
AD9070, AD9071* 10 Bit, 100 MSPS A/D Converters	3-14
AD9050 and AD9051* 10 Bit, 60 MSPS A/D Converters	3-17
AD9200 and AD9280 10-bit/8-bit, Low Power Sampling A/D Converters	3-19
AD9201* and AD9281* Dual Channel, 10-bit/8-bit, 20 MSPS A/D Converters	3-22
12 Bit High Speed A/D Converters	**3-25**
AD9224 and AD9225 12 Bit, High Speed A/D Converters	3-26

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 3 - ANALOG TO DIGITAL CONVERTERS (con't)

Model/Topic	Page No
14-16 Bit High Speed A/D Converters	**3-33**
AD9240 and AD9241 14 Bit High Speed A/D Converters	3-35
AD9260* 16 Bit, Oversampling A/D Converter	3-37
CCD/CIS Imaging Processors	**3-41**
AD9807 and AD9805 6 MSPS CCD/CIS Signal Processors	3-42
AD9801 and AD9802 10 Bit, 18 MSPS CCD Signal Processor	3-46
Single Supply, Low Power A/D Converters	**3-49**
New 8-10 Bit A/D Converters	**3-51**
How Does the Auto Power Down Feature Work?	3-54
AD7819 and AD782X Family 8 Bit A/D Converters	3-56
AD781X* and AD741X* Families 10 Bit A/D Converters	3-57
AD7827 8 Bit, 2 MSPS Serial A/D Converter	3-58
AD7822, AD7825 and AD7829 8 Bit, 2 MSPS Parallel A/D Converters	3-59
AD7819* 8 Bit, 200 ksps Parallel A/D Converters	3-62
AD7823 8 Bit, 200 ksps Serial A/D Converters	3-63
AD7813 8/10 Bit, 500 ksps Parallel A/D Converter	3-64
AD7810, AD7811, AD7812 10 Bit, 500 ksps Serial A/D Converters	3-65
AD7816/AD7817*/AD7818* ¼-Channel 10-Bit ADCs w/ On-Board Temp Sensor	3-72
AD7416*/AD7417*/AD7818* ¼-Channel 10-Bit ADCs w/ On-Board Temp Sensor	3-75
The On-Chip Temperature Sensor	3-76
12 Bit A/D Converters	**3-77**
AD7889 12 Bit, 600 ksps, Serial A/D Converter	3-79
AD7887*, AD7888* 12 Bit, 200 ksps, 2/8 Channel, Serial A/D Converters	3-80
AD7864* 12 Bit, 4 Channel, Simultaneous Sampling A/D Converter	3-82
14-16 Bit A/D Converters	**3-85**
AD7863* Dual Channel, Simultaneous Sampling A/D Converter	3-86
Vector Motor Control Using the AD7863	3-90
AD7894* 5V, 14 Bit Serial Bipolar A/D Converter	3-91
AD97X Family 16 Bit, Switched Capacitor A/D Converters	3-92
AD974* 16 Bit, 150 ksps, 4 Channel A/D Converter	3-96

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 3 - ANALOG TO DIGITAL CONVERTERS (con't)

Model/Topic	Page No
Voltage - to - Frequency and Frequency - to - Voltage Converters	**3-99**
AD7741* 5 MHz Voltage - Frequency Converter	3-100
AD7742* 5 MHz Dual Channel Voltage-Frequency Converter	3-101
Sigma-Delta (Σ–Δ) A/D Converters	**3-103**
What is a Sigma-Delta Converter?	3-104
AD7730 and AD7731 High Resolution Industrial A-D Converters	3-121
"Tare" Weight Compensation - What is it?	3-125
AD7750 Product to Frequency Converter	3-142
AD7723* 1.2 MHz Sigma Delta A-D Converter	3-144
AD7705*, AD7706* 16 Bit Sigma Delta A/D Converter	3-147
AD7729* 15 Bit, 2 Channel, Simultaneous Sampling Sigma Delta A/D Converter	3-149
AD7720 Sigma Delta Modulator	3-152
Industrial, Multi-Channel Signal Conditioning A/D Converter	3-155
AD280*, 4 Channel Industrial Signal Conditioning + 16 Bit A/D Converter	3-156

SECTION 4 - DIGITAL TO ANALOG CONVERTERS

Model/Topic	Page No
High Speed D/A Converters	**4-3**
Which Specs are Important for High Speed DACs?	4-4
AD9731* 10-Bit, 125 MSPS D/A Converter	4-6
High Speed, 8-14 Bit TxDAC ("Transmit DAC") Family	**4-9**
AD975X* 10-14 Bit, 125 MSPS, TxDAC Family	4-11
AD9764 14 Bit, 80 MSPS TxDAC	4-13
High Speed, 10-12 Bit Interpolating D/A Converters	**4-15**
DAC Images	4-16
AD9761* Dual 10-Bit, 2X Interpolating TxDAC	4-19
AD9774* 12 Bit, 4X Interpolating TxDAC	4-21
AD768 "B" 16-Bit, 40 MSPS D/A Converter	4-24

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 4 - DIGITAL TO ANALOG CONVERTERS (con't)

Model/Topic	Page No
Direct Digital Synthesis	**4-31**
What is Direct Digital Synthesis?	4-32
AD9851* 175 MHz Direct Digital Synthesizer	4-37
AD9830, AD9831, AD9832 and AD9850 CMOS Direct Digital Synthesizers	4-39
AD9830, AD9831 and AD9850 - Key Model Differences	4-40
AD9850 DDS/DAC Synthesizer	4-41
AD9850 vs AD9955	4-43
AD9850 Evaluation Boards	4-44
Digital I and Q Modulation	**4-47**
A Typical I and Q Modulator	4-48
AD9853* Digital QPSK Modulator	4-49
AD9853BR-2* Programmable Digital Modulator	4-51
General Purpose, Single Supply, Low Power D/A Converters	**4-53**
AD7376* Rail-to-Rail, 7-Bit Digital Potentiometer	4-54
AD7801 8 Bit Rail-Rail Parallel D/A Converter	4-59
AD7302 and AD7303 Dual, 8 Bit Rail-Rail Parallel/Serial D/A Converters	4-60
AD7304*, AD7305* 8 Bit, Quad, Serial/Parallel D/A Converters	4-62
AD7394-AD7397* Family 10-Bit/12-Bit, Dual Micropower D-A Converters	4-65
AD5300, AD5310 and AD5320 8 /10/12 Bit Rail-Rail Serial D/A Converters	4-67
AD5302*, AD5312* and AD5322* 8 /10/12 Bit Dual Rail-Rail Serial D/A Converters	**4-69**
AD5303*, AD5313* and AD5323* 8 /10/12 Bit Rail-Rail Serial D/A Converters	4-73
Additional High Performance 12-14 Bit A/D Converters	4-74
DAC8043A 12-Bit 4 Quadrant Multiplying Serial D/A Converter	4-75
AD7838* and AD7839* 13 Bit Octal, Rail-Rail Parallel D/A Converters	4-76

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 5 - DIGITAL SIGNAL PROCESSING

Model/Topic	Page No
DSP Product Families Overview	**5-2**
ADI DSP Product Families	5-3
16 Bit DSP Processors	**5-4**
New ADSP-218X Family Members	5-5
High-Performance, Fixed-Point DSP Processors	**5-11**
ADSP-2183-CAP*	5-8
ADSP-2187L - 160 kbytes SRAM @ 52 MIPS	5-9
ADSP-2189L* - 192 kbytes SRAM @ 52 MIPS	5-10
16 Bit Roadmap - 3 Generations	5-11
32 Bit DSP Processor	**5-12**
32 Bit Roadmap	5-13
Industrial Temperature and Military SMD SHARCS™	**5-17**
Quad SHARC MCM (Multi-Chip Modules)	5-18
AD14060 General Purpose Multi-Processor Solution	5-20
AD14160 General Purpose Multi-Processor Solution	5-21
Remote Access Server Modems	**5-26**
ADSP-21mod870 Key Features	5-28
ADSP-21mod970 Key Features	5-30
DSP Tools	**5-33**
Systems and Solutions from Analog Devices	**5-41**
Algorithm Building Blocks available on ADI DSPs	5-43
Audio Algorithms for the SHARC Product Line	5-44
Telephony Algorithms	5-45
Telephony/Modem Algorithms	5-46
Compression Algorithms	5-48
H.324 Videophone	5-49
Salem 3-Phase Energy Meter	5-51

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 6 - DATA CONVERTER SUPPORT COMPONENTS

Model/Topic	Page No
Voltage References	**6-3**
AD1581-AD1585 1.2V to 5.0V Micropower, Precision Voltage References	6-4
ADR290, ADR291 ADR292 and AD2R93 Micropower Precision References	6-7
AD2RX Family	6-8
A New Family of Unique Video Speed Products...	**6-9**
AD8184 4:1, 700MHz Video Multiplexer	6-10
Application Example: 4 x 4 Crosspoint Switch	6-11
What's a Crosspoint Switch?	6-12
AD8108 and AD8109 8 x 8 Video Crosspoint Switches	6-13
AD8110 and AD8111 16 x 8 Video Crosspoint Switches	6-14
CMOS Switches and Multiplexers	**6-17**
Important CMOS Switch Parameters...	6-18
Bandwidth Analysis	6-19
ADG719*, ADG736* Single, Dual CMOS SPDT Switches	6-20
ADG701* and ADG702* Low Ron Precision CMOS SPST Switches	6-21
ADG721*, ADG722* and ADG723* Dual CMOS SPST Switches	6-22
ADG711*, ADG712* and ADG713* Quad CMOS SPST Switches	6-23
ADG661, ADG662 and ADG663 Quad CMOS SPST Switches	6-24
ADG451, ADG452 and ADG453 Quad CMOS SPST Switches	6-25
ADG774 Quad 2:1 Multiplexer	6-26
Single, Quad and Octal Channel Input Protectors	**6-27**
What Are Channel Protectors?	6-28
ADG465, ADG466 and ADG467 Single, Triple and Octal Channel Protectors	6-29

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 7 - COMPUTER INTERFACE PRODUCTS

Model/Topic	Page No
Electromagnetic Compatibility and European EMC Requirements	**7-3**
EMC on Interface Products - Why is it so Important?	7-4
Electromagnetic Compatibility - Definitions	7-8
Who Must Comply with the EMC Directive?	7-9
IEC 1000-4-x Basic Immunity Standards	7-10
ESD Test Method IEC1000-4-2	7-11
IEC1000-4-2 vs. HBM Testing	7-12
ESD Discharge Waveforms	7-13
EFT Testing	7-14
IEC1000-4-3 Electric Field Immunity	7-16
Conducted Emissions Testing	7-19
Radiated Emissions Test Setup	7-20
ESD/EFT Protection	7-21
RS-232E Line Driver/Receiver	**7-23**
ADM1385*, ADM3202* and ADM3222* 3V, Low Power RS-232 Transceivers	7-24
ADM3311 Serial Port RS-232 Driver/Receiver	7-25
ADM14185E* and ADM14196E* 15 kV Protected RS-232 Line Driver/Receiver	7-27
RS-485 Transceivers	**7-29**
ADM3485*, ADM3491 3.3V Full Duplex 20 Mbps EIA RS-485 Transceivers	7-30
ADM483E* 15 kV Protected EIA RS-485 Transceiver	7-32
ADM488* and ADM489* Full Duplex Low Power EIA RS-485 Transceivers	7-33
V.35 Transceiver	**7-35**
ADM1345* Single Supply V.35 Transceiver	7-36
Digital Isolators	**7-39**
AD260*, AD261* High Speed, High Voltage Digital Logic Isolators	7-40
AD260 Isolated Transformer - Typical Drive and Regulation	7-44
AD260, AD261 Ordering Guide	7-47

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 8 - POWER MANAGEMENT PRODUCTS

Model/Topic	Page No
What is Power Management?	8-2
Why is Power Management Becoming So Important?	8-3
Distributed Power Supply System	8-6
Power Management Signal Chain - Portable Computer	8-7
Power Management Signal Chain - Pagers, PDA's	8-8
Power Management Signal Chain - Cellular Phones	8-9
Power Management Products - Part Numbering System	8-10
Low Drop Out (LDO) Regulators	**8-13**
Why Linear Regulators?	8-14
anyCAP^{tm} LDO (Low Drop Out)Regulators	**8-15**
Typical LDOs vs anyCAP^{tm} LDO Regulators	8-17
ADP3300, ADP3301 and ADP3303 anyCAP^{tm} Low Dropout Linear Regulators	8-18
ADP3302 anyCAP^{tm} Dual, Low Dropout Linear Regulator	8-20
ADP3310 Precision, Voltage Regulator/Controller	8-22
Switch-Mode DC-DC Converters	**8-21**
Specifying Switch Mode DC-DC Converters	8-26
How to Choose a Switching Regulator	8-27
ADP1109/ADP1109A Low Cost, Switch-Mode DC-DC Converter	8-30
ADP3000 High Frequency Switching Regulator	8-32
AD1147 and AD1148 High Efficiency, Step-Down Switching Regulators	8-34
ADP3050* Wide Input Voltage Range Step-Down Switching Regulator	8-36
Switched Capacitor Voltage Converter	**8-33**
ADP3603, ADP3604 Switched Capacitor Voltage Converters	8-40
Battery Charger Controllers	**8-42**
ADP3810 / ADP3811 Battery Charger Controllers	8-43
ADP3810, ADP3811 Simplified Battery Charger Circuit	8-45
ADP3810, ADP3811 High Efficiency Buck Battery Charger	8-46
ADP3801* and ADP3802* Complete Dual Battery Charging IC	8-48

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 9 - MICROPROCESSOR SUPERVISORY COMPONENTS

Model/Topic	Page No
Power Supply Monitors	**9-2**
ADM809 and ADM810 Vcc Monitors	9-3
ADM811* and ADM812* Vcc Monitors	9-5
ADM6315 Vcc Monitor	9-7
ADM9264 and ADM9268* Quad Supply Monitors	9-8
ADM9261* Triple Power Supply Monitor	9-10
Microprocessor Supervisory Circuits	**9-11**
ADM869X Series Microprocessor Supervisory Circuits	9-12
ADM9690 Microprocessor Supervisory Circuit	9-13
ADM1232 Microprocessor Supervisory Circuit	9-15
Hardware Monitoring System	**9-16**
ADM9240* ADC-Based System Hardware Monitor	9-17

SECTION 10 - AUDIO PRODUCTS

Model/Topic	Page No
Audio Amplifiers	**10-3**
SSM2211 1 Watt Audio Power Amplifier	10-4
SSM2275 and SSM2475* Dual/Quad Rail-Rail Audio Amplifiers	10-6
Surround Sound System	**10-7**
SSM2005 Circle Surround Audio Surround System	10-9
Digital Audio Systems	**10-13**
AD1857, AD1858 Low Cost, Integrated Stereo D-A Converters	10-14
Digital Rate Converter	**10-17**
AD1892* Integrated Digital Receiver/Rate Converter	10-18
AD1819A* AC'97 Soundport CODEC	10-21

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 11 - MONOLITHIC SENSOR PRODUCTS

Model/Topic	Page No
Temperature Sensors	**11-3**
ADT45* and ADT50* Low Voltage Temperature Sensors	11-5
AD22105, ADT05* Resistor Programmable Thermostat	11-6
ADT14, ADT15* Quad Setpoint, Programmable Temperature Monitor/Controller	11-7
ADT70* Platinum RTD Conditioning Circuit	11-10
Monolithic Accelerometers	**11-13**
Where Are Accelerometers Used?	11-14
ADXL05 Monolithic ± 5g Accelerometer With Signal Conditioning	11-15
How Does the ADXL05 Work?	11-18
A Comparison of the ADXL05 to the ADXL50...	11-20
ADXL150 and ADXL250 Low Power, Low Noise, Single/Dual Axis Accelerometers	11-21
ADXL202* Low Cost, Dual Axis Accelerometer	11-23

SECTION 12 - VIDEO GRAPHICS PRODUCTS

Model/Topic	Page No
Digital Video Encoders	**12-3**
What are Digital Video Encoders?	12-4
Video Signal Formats	12-6
Digital Video Encoder Product Family	12-8
What is Macrovision?	12-9
ADV7175A and ADV7176A - Simplified Diagram	12-10
ADV7177* and ADV7178*	12-13
ADV7174*	11-14
Digital Video Decoders	**12-15**
What are Digital Video Decoders?	12-16
ADV7185* Video Decoder with Comb Filtering and H,V Scaling	12-17
ADV7185 - Security Systems	12-21
D/A Converters for Video Graphics	**12-23**
ADV7123 and ADV7127 10 Bit, Single/Triple Video D/A Converters	12-24
ADV7129 8 Bit, 360 MHzTrue Color Video DAC with On-Board PLL	12-25

TABLE OF CONTENTS

(*) Denotes Preliminary Technical Information

SECTION 13 - MOTOR CONTROL PRODUCTS

Model/Topic	Page No
Why DSP in Motor Control?	13-2
Applications for DSP-Based Motor Control	13-3
Analog & Digital IC Motor Control Signal Chain	13-4
Analog & Digital IC Motor Control Signal Chain - Integration	13-5
ADMC300,ADMC330, ADMC331 - Key Model Differences	13-6
ADMC300, ADMC330, ADMC331 - Key Specs and Features	13-8
ADMC300 - Servo DSP Motor Controller	13-9
ADMC330- DSP Motor Controller	13-10
ADMC331- DSP Motor Controller	13-11
Motor Control Development Tools	13-12
ADMC300 Evaluation Board	13-13
ADMC330 Evaluation Board	13-14

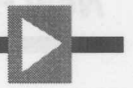
SECTION 1
AMPLIFIERS

High Speed Amplifiers

Precision, Low Power Amplifiers

High Speed Comparators

Instrumentation Amplifiers



High Speed, Voltage and Current Feedback Amplifiers

X.F.C.B.

(Extra Fast Complementary Bipolar)

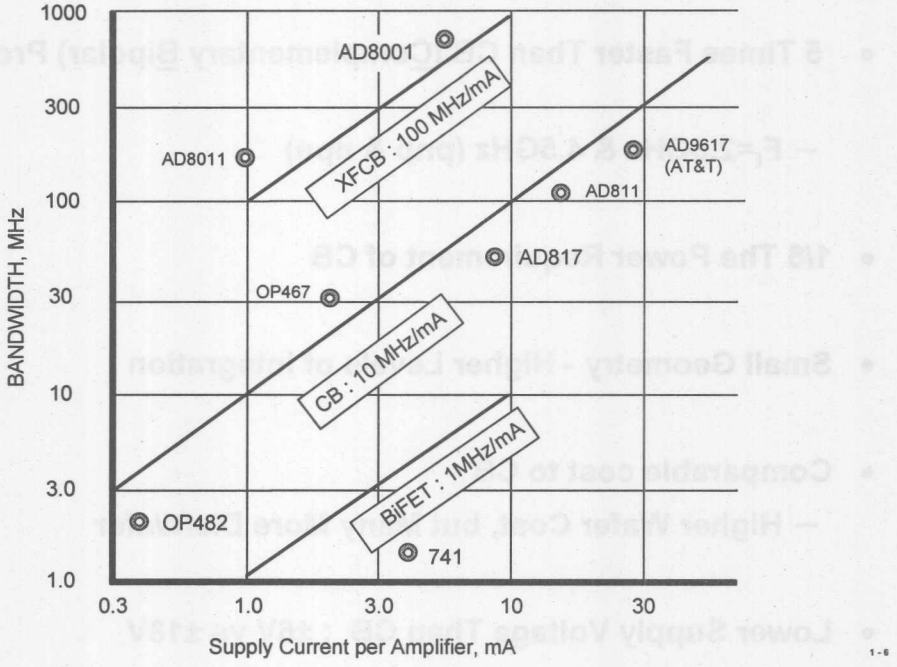
A Proprietary New High Speed Process from Analog Devices

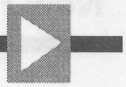
X.F.C.B.
(Extra Fast Complementary Bipolar)

- 5 Times Faster Than CB (Complementary Bipolar) Process
  - F_t=2.5GHz & 4.5GHz (pnp & npn)
- 1/8 The Power Requirement of CB
- Small Geometry - Higher Levels of Integration
- Comparable cost to CB
  - Higher Wafer Cost, but Many More Die/Wafer
- Lower Supply Voltage Than CB : ±6V vs ±18V

1-5

XFCB Provides the Highest Speed - Supply Current Ratio!





High Speed
Current Feedback Amplifiers

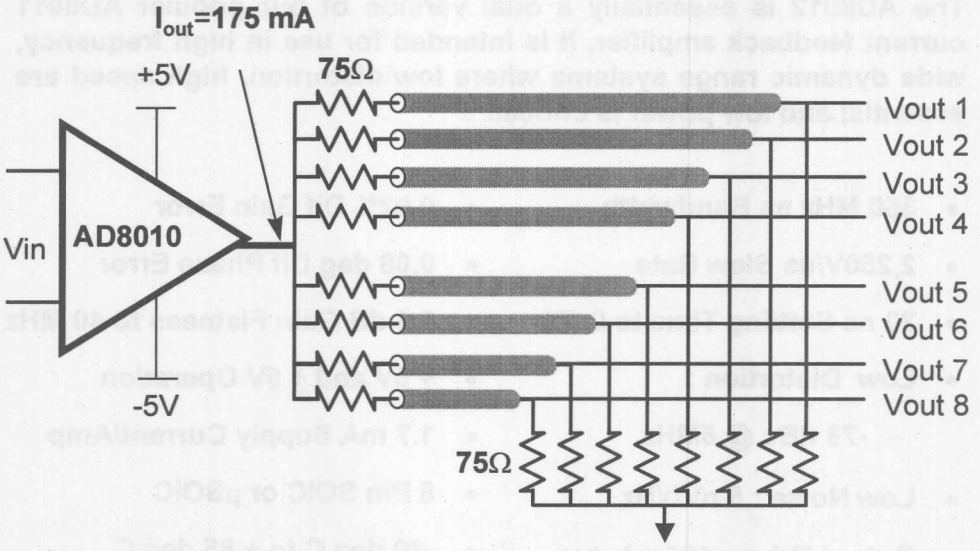
AD8010
230 MHz, High Current Output Video Amplifier

The AD8010 is capable of driving up to eight (8) 75 Ω , back-terminated loads while maintaining *exceptional* differential gain and phase performance!

- **175 mA Minimum Output Current**
- **230 MHz Small Signal Bandwidth**
- **800 V/us Slew Rate**
- **Differential Gain and Phase : 0.02%, 0.03 deg**
- **0.1 dB Gain Flatness to 60 MHz**
- **Low 2nd Harmonic Distortion : -72 dBc @ 1MHz**
- **Power Supply : ± 5V @ 16mA**
- **8 Pin DIP, "Thermal Coastline" SOIC-8 and Wide Body SOIC-16 Packages**

1-8

AD8010:
Video Distribution Amplifier



1-9

AD8012
350 MHz Dual Current Feedback Amplifier

The AD8012 is essentially a dual version of our popular AD8011 current feedback amplifier. It is intended for use in high frequency, wide dynamic range systems where low distortion, high speed are essential and low power is critical.

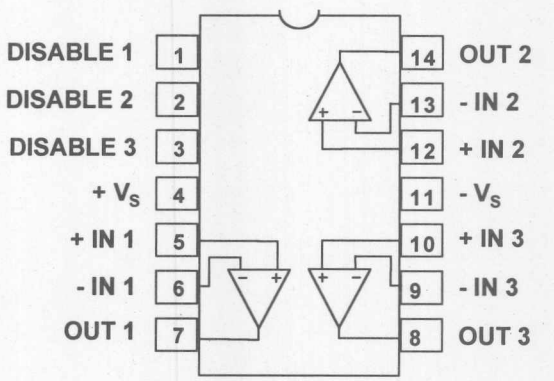
- **350 MHz ss Bandwidth**
- **2,250V/us Slew Rate**
- **20 ns Settling Time to 0.1%**
- **Low Distortion :**
  - **-78 dBc @ 5MHz**
- **Low Noise : 5 nV/√Hz**
- **Output Drive : 125mA, typ**
- **0.02% Dif Gain Error**
- **0.06 deg Dif Phase Error**
- **0.1 dB Gain Flatness to 40 MHz**
- **+ 5V and ± 5V Operation**
- **1.7 mA Supply Current/Amp**
- **8 Pin SOIC or μSOIC**
- **-40 deg C to + 85 deg C**

1 - 10

AD8023
Low Cost, High Current Output Triple Video Amplifier

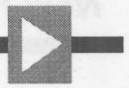
The AD8023 is a higher performance version of our popular AD8013

- Higher Output Drive Current:
  - 70 mA vs 25 mA
  - Drives 1000 pf Cap Load
- Higher Unity Gain Bandwidth:
  - 250 MHz vs 140 MHz
- 1200V/us Slew Rate
- 30 ns Settling to 0.1%
- 0.06%/0.02 deg Differential Gain/Phase
- 2 nV/ √ Hz Input Voltage Noise
- High Speed DISABLE Function :
  - 30 ns Turn-Off Time
- + 5V to ± 7.5V Operation



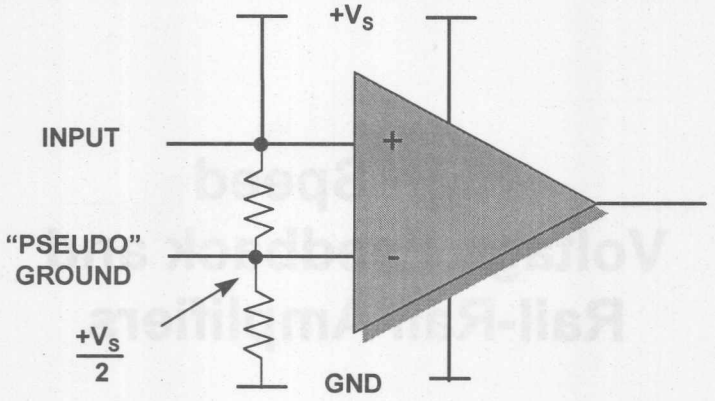
14 pin SOIC

1-11



High Speed Voltage Feedback and Rail-Rail Amplifiers

What is a Rail-Rail Amplifier?

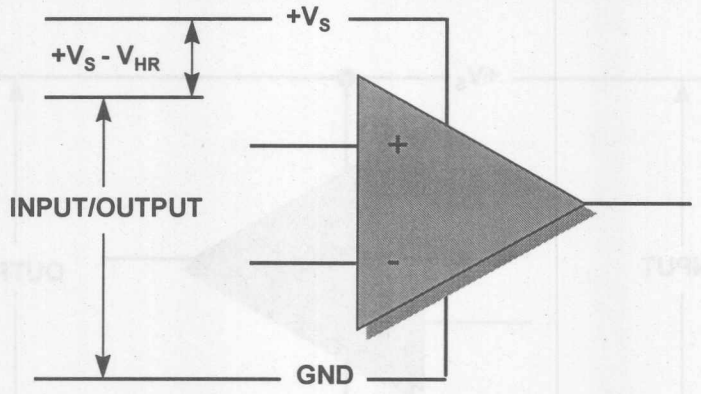


Conventional Op Amp Used in a "Single Supply" Mode:

- **Most Op Amps Can Operate From a Single Supply If Their "Ground" Is Biased Between the Positive Rail and Ground.**
- **Standard Op Amps Will Require 2-3 Volts of "Headroom" Between Supply Rails.**

1-14

What is a Rail-Rail Amplifier ? (con't)

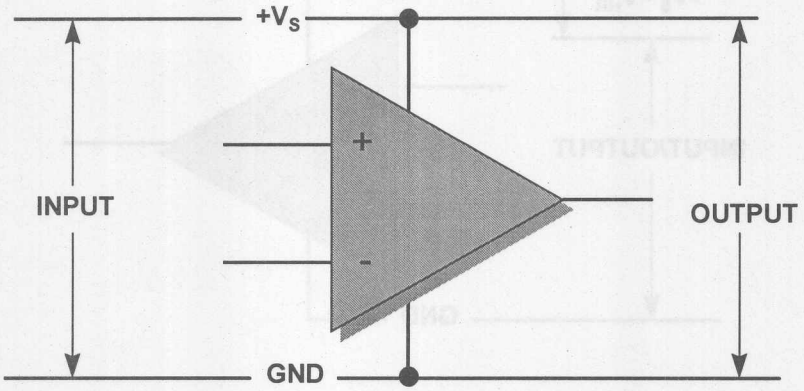


True "Single Supply" Op Amp

- True Single Supply Op Amps Can Operate Down to Their Negative Rail (Ground)
- Sometimes Still Require 2-3 Volts of Headroom V_{HR} Between the Positive Excursion and the Positive Rail.

1 - 15

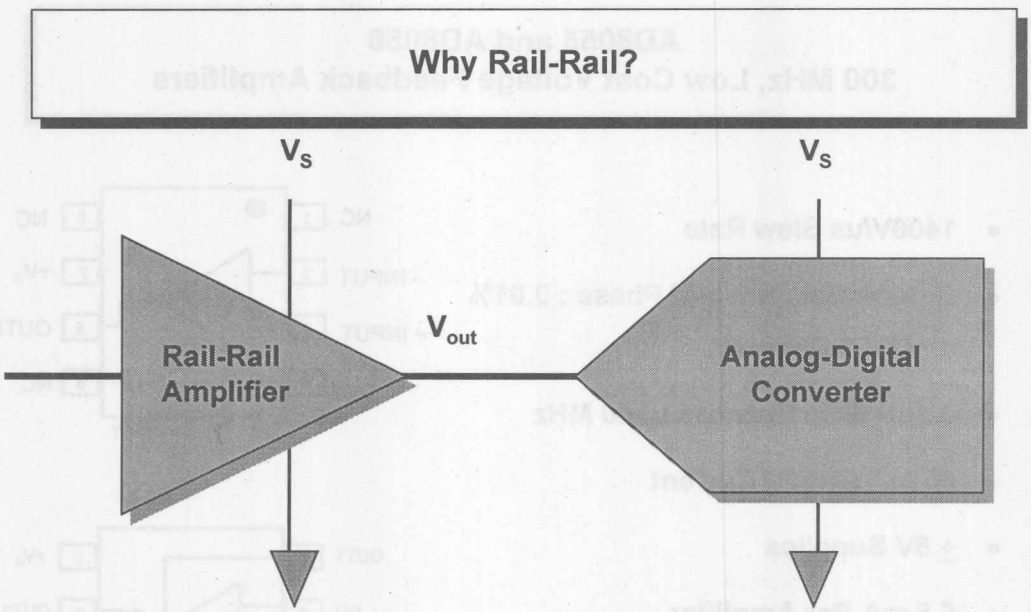
What is a Rail-Rail Amplifier ? (con't)



True Rail-Rail Op Amp

- **True Rail-Rail Op Amps Can Swing to Within a Few Millivolts of Their Supply Rails, Either on the Input, the Output or Both.**

1-16

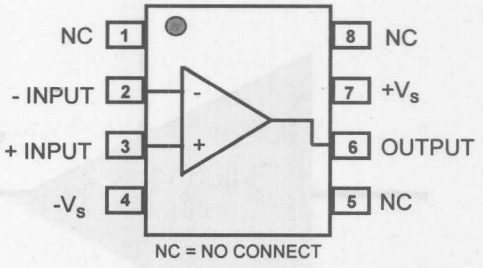


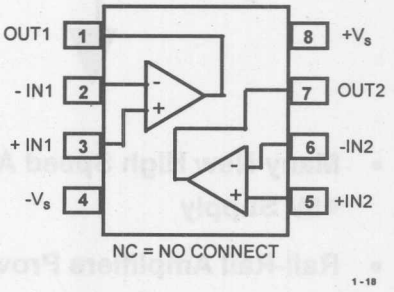
- Many New High Speed A-D Converters Operate From Single +3V to +5V Supply
- Rail-Rail Amplifiers Provide Maximum Dynamic Range

1-17

AD8055 and AD8056
300 MHz, Low Cost Voltage Feedback Amplifiers

- **1400V/us Slew Rate**
- **Differential Gain and Phase : 0.01% and 0.02 Degree**
- **0.1dB Gain Flatness to 40 MHz**
- **60 mA Output Current**
- **± 5V Supplies**
- **5.5 mA Per Amplifier**
- **8 Pin DIP, SOIC and SOT23-5 (AD8055) or microSOIC (AD8056)**

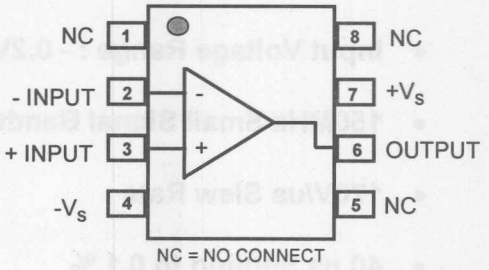


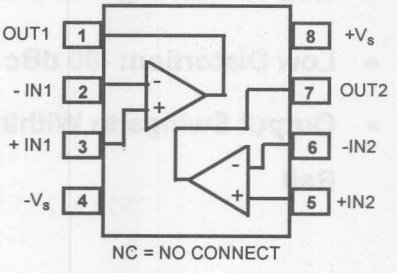


1-18

AD8051 and AD8052
110 MHz, Single/Dual *Rail-Rail* Voltage Feedback Amplifiers

- **Input Voltage Range : - 0.2V to + 4.0V**
- **110MHz Small Signal Bandwidth**
- **145V/us Slew Rate**
- **50 ns Settling to 0.1 %**
- **0.03 %/0.03 deg Diff Gain /Phase Error**
- **Low Distortion: -80 dBc @ F_c = 1 MHz**
- **Output Swings to Within 25 mV of Either Rail**

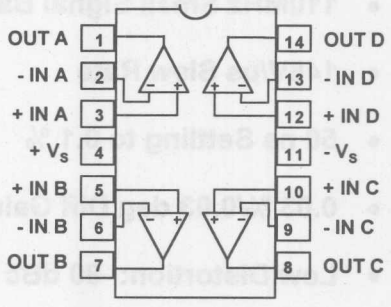




1 - 19

AD8054
150 MHz, Quad *Rail-Rail* Voltage Feedback Amplifier

- **Input Voltage Range : - 0.2V to + 4.0V**
- **150MHz Small Signal Bandwidth**
- **170V/us Slew Rate**
- **40 ns Settling to 0.1 %**
- **0.02 %/0.05 deg Diff Gain /Phase Error**
- **Low Distortion: -80 dBc @ F_c = 1 MHz**
- **Output Swings to Within 25 mV of Either Rail**

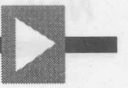


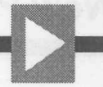
1 - 20

AD8051, AD8052 and AD8054

- 45 mA Output Drive Current
- Fully Specified at +3V, +5V and ±5V Supply Voltages
- Low Power Consumption :
  - AD8051, AD8052 : 4.4 mA per amplifier
  - AD8054 : 2.75 mA per amplifier
- Compact Packages:
  - AD8051 : 8 pin SOIC and 5 lead SOT-23
  - AD8052 ; 8 PIN soic AND μSOIC
  - AD8054 : 14 Pin DIP and TSSOP
- -40 deg C to + 85 deg C Operating Temp Range

1 - 21





Precision, Low Power Amplifiers

preliminary data

AD8551/8552/8554
"Zero Drift" Chopper Amplifiers

The AD8551/52/54 are low cost, single, dual and quad amplifiers that require no external components to achieve virtually "zero drift" performance!

- **Virtual "Drift Free" Performance : 0.03 uV/deg C**
- **Low Input Offset Voltage : 5 uV**
- **Low Input Bias Current : 20 pA**
- **Rail-Rail Input and Output**
- **120 dB PSRR, CMRR**
- **Overload Recovery < 2 ms**
- **Single Supply Operation : 2.7V to 5V**
- **Only 650 uA per amplifier**
- **8/14 Pin DIP and SOIC Packages**
- **- 40 deg C to + 125 deg Operating Range**

1 - 24

* preliminary data

OP181/281/481 and OP186*
Single/Dual/Quad Micropower Amplifiers

The OP181/281/481 and OP186 are the Industry's Lowest Power, Rail-Rail Amplifiers!

- **Supply Current Only 4μA Maximum Over Entire Input and Output Range!**
- **OP181 (single), OP281 (dual) and OP481 (quad)**
- **OP186 Similar to OP181, Except, -**
  - **SOT-23 Package**
  - **3 mV Input Offset Voltage, NoTrim Pins**
- **100 kHz Small Signal Bandwidth**
- **Rail-to-Rail Outputs**

1 - 25

OP250 and OP450
4 MHz, CMOS Rail-Rail Amplifiers

OP250 (dual) and OP450 (quad) are performance-enhanced versions of our AD853X Family.

- **4 MHz Unity Gain Bandwidth**
- **6.5V/us Slew Rate**
- **Rail-Rail Inputs and Outputs, with no Phase Reversal**
- **Output Current : 250 mA**
- **Stable with Capacitive Loads up to 47 nanofarads**
- **Single Supply Operation : 2.7 to 6 Volts**
- **Low Supply Current : 600 uA per amplifier**
- **- 40 deg C to + 125 deg C Operating Range**
- **8/14 pin SOIC and TSSOP Package Options**

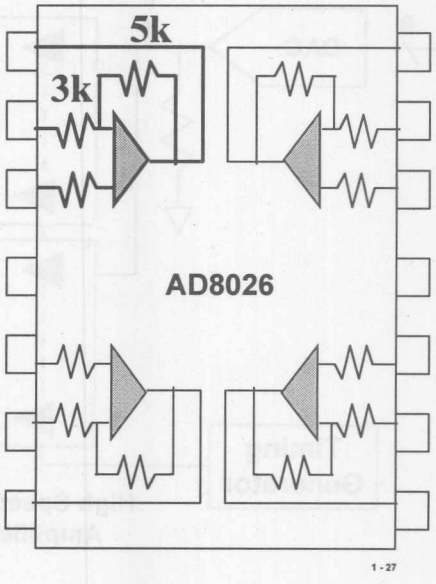
1 - 26

* preliminary data

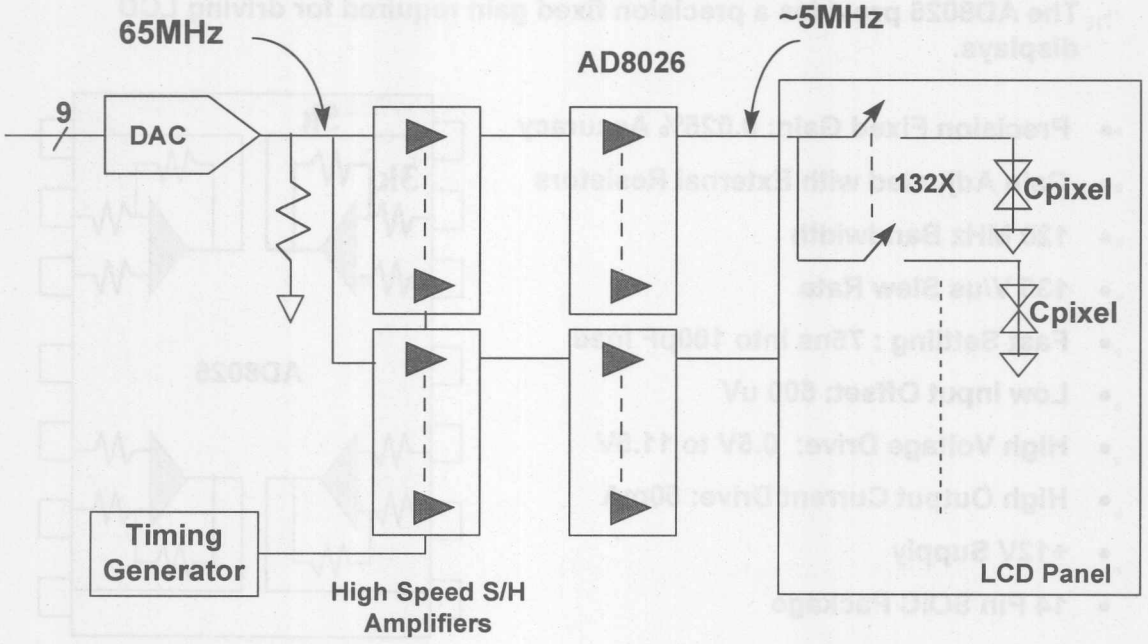
AD8026
High Speed Quad Amplifier

The AD8026 provides a precision fixed gain required for driving LCD displays.

- Precision Fixed Gain: 0.025% Accuracy
- Gain Adjusted with External Resistors
- 120 MHz Bandwidth
- 135 V/us Slew Rate
- Fast Settling : 75ns into 100pF load
- Low Input Offset: 500 uV
- High Voltage Drive: 0.5V to 11.5V
- High Output Current Drive: 50mA
- +12V Supply
- 14 Pin SOIC Package



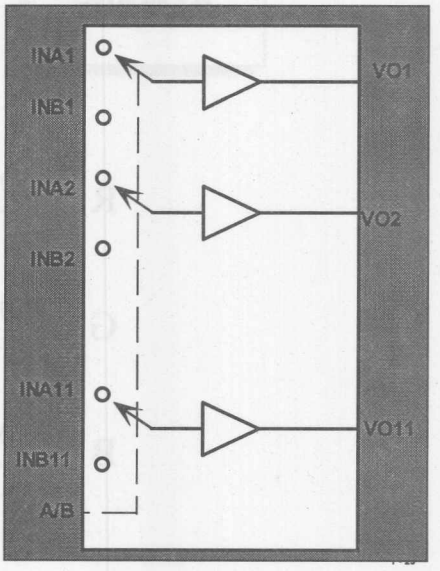
LCD Display Signal Chain

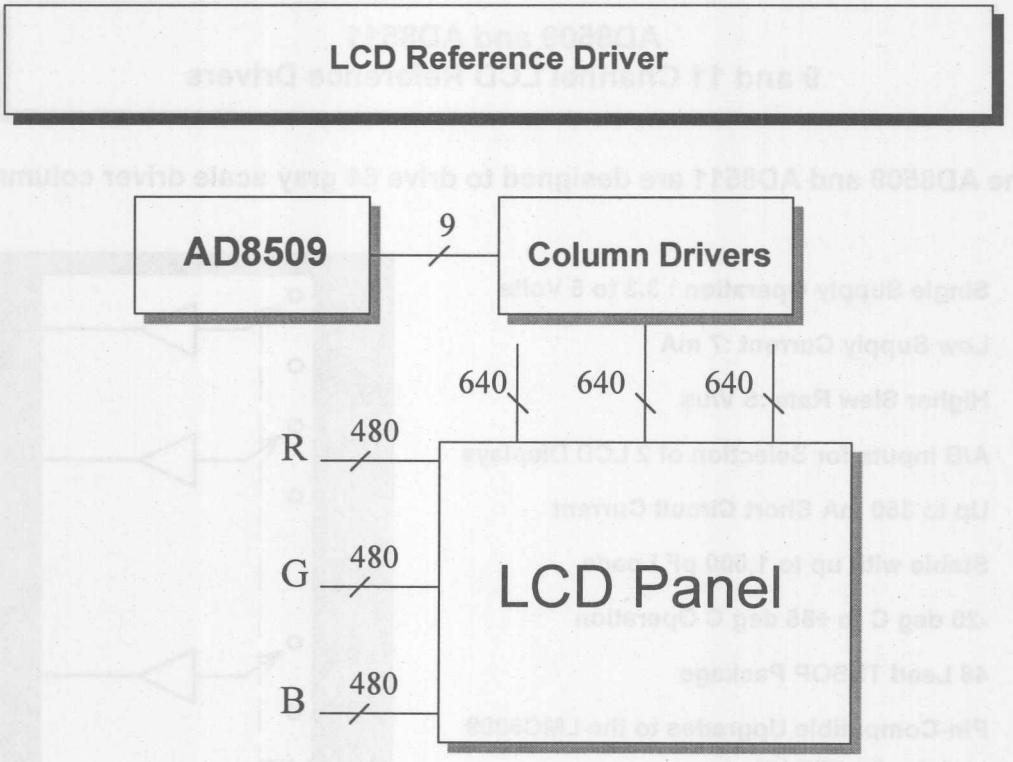


AD8509 and AD8511
9 and 11 Channel LCD Reference Drivers

The AD8509 and AD8511 are designed to drive 64 gray scale driver columns.

- **Single Supply Operation : 3.3 to 5 Volts**
- **Low Supply Current :7 mA**
- **Higher Slew Rate :5 V/us**
- **A/B Inputs for Selection of 2 LCD Displays**
- **Up to 350 mA Short Circuit Current**
- **Stable with up to 1,000 pF Loads**
- **-20 deg C to +85 deg C Operation**
- **48 Lead TSSOP Package**
- **Pin-Compatible Upgrades to the LMC6009 and the CL-FP6131**



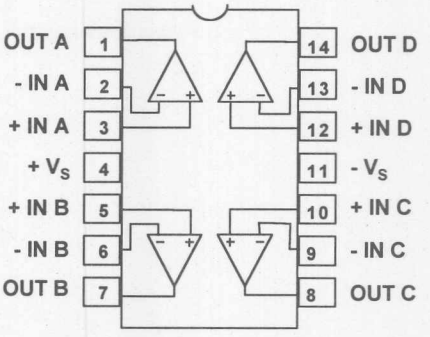

LCD Reference Driver
AD8509
9
Column Drivers
640
640
640
R
480
G
480
B
480
LCD Panel

1 - 30

* preliminary data

AD824
2 MHz, Quad, Rail-Rail FET Input Amplifier

- Wide Bandwidth: 2 MHz
- Slew Rate: 2 V/us
- Low Input Offset Voltage : 300 uV max
- Very Low Input Bias Current: 2 pA
- Wide Input Voltage Range
- No Phase Reversal
- Rail-to-Rail Output Swing
- + 3 V to ± 15 V Supply Operation
- Low Supply Current: 500 uA/Amp
- 14 Pin DIP and SOIC; 16 Pin SOIC



1-31

High Speed Comparators

preliminary data

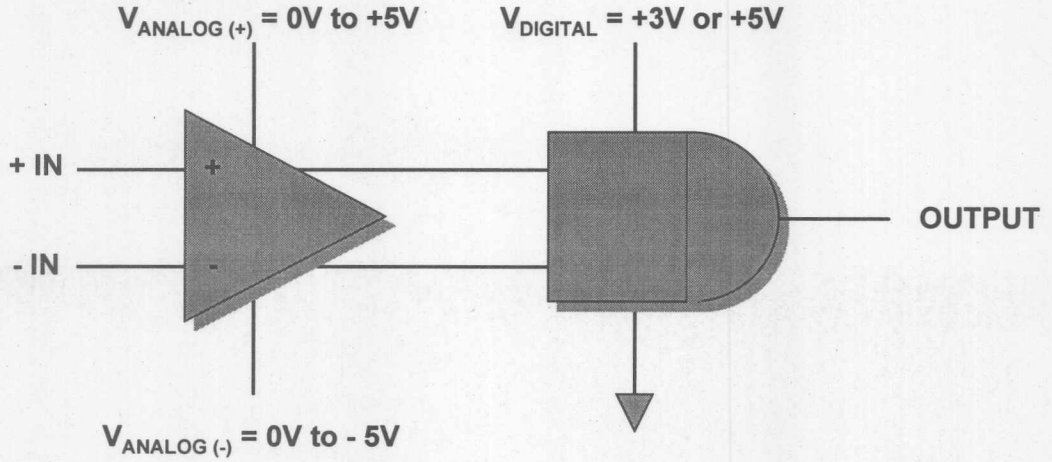
AD8561 and AD8564*
6 ns Single and Quad High Speed Comparators

The AD8561 and AD8564 are improved performance, pin-pin upgrades to the LT1016 and MAX901, respectively.

- **6 ns Typical Propagation Delay**
- **Symmetrical Rise/Fall Times**
- **Input Common Mode Range Includes Ground**
- **Separate Analog and Digital Supply Pins (AD8564)**
- **Compatible with TTL/CMOS Logic**
- **No Active Pull Up Required**
- **LATCH Function (AD8561)**
- **8/16 Pin DIP, SOIC and TSSOP Packages**
- **-40 deg C to + 85 deg C**

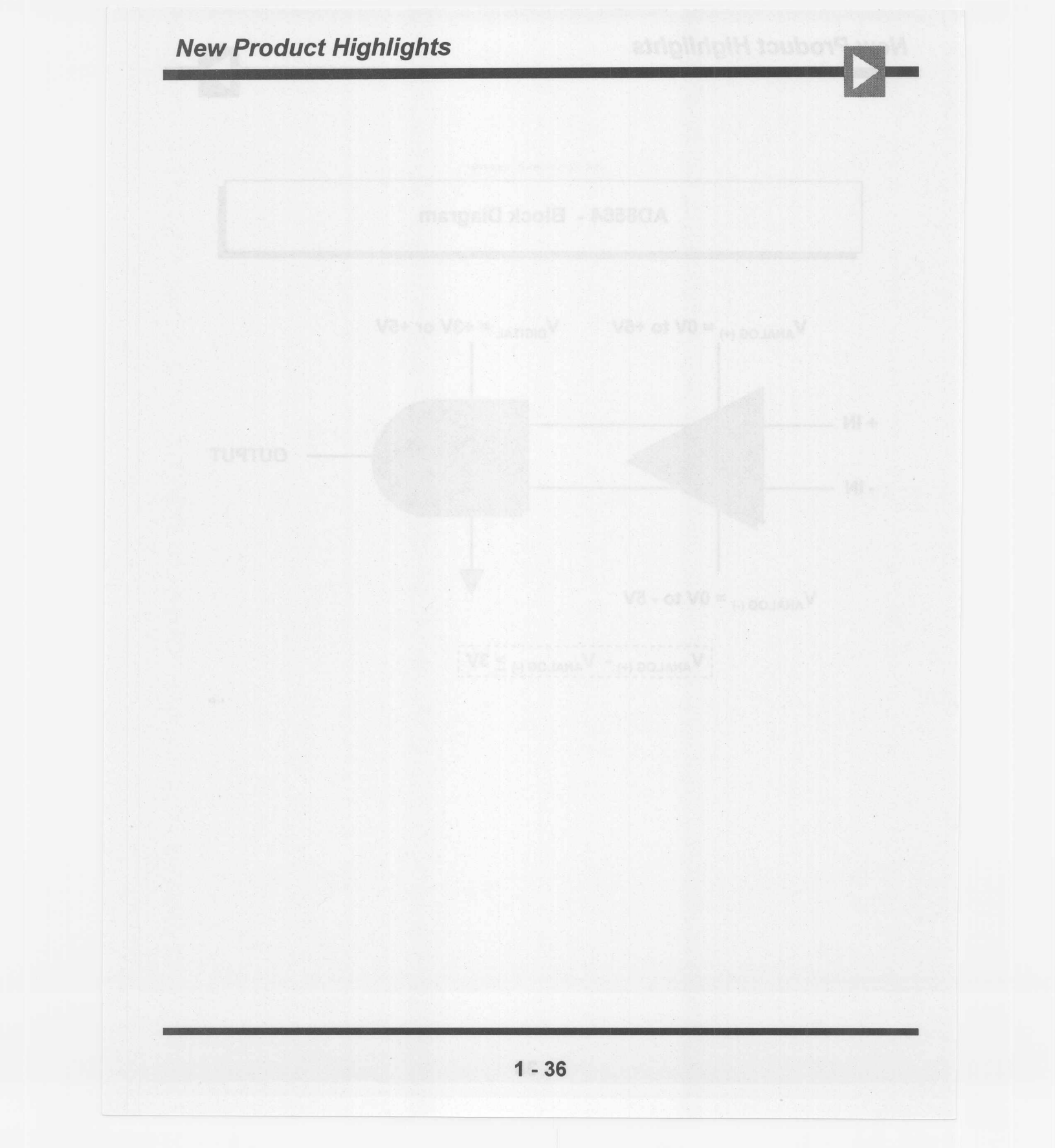
1-34

AD8564 - Block Diagram



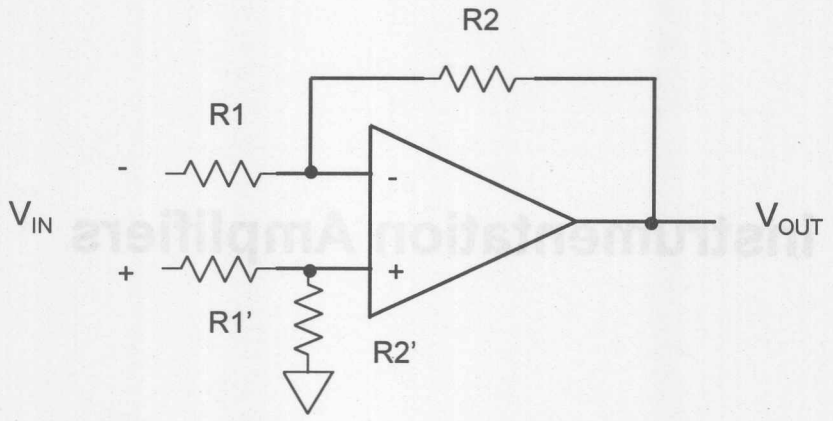
$V_{ANALOG\ (+)} - V_{ANALOG\ (-)} \geq 3V$

1 - 35



Instrumentation Amplifiers

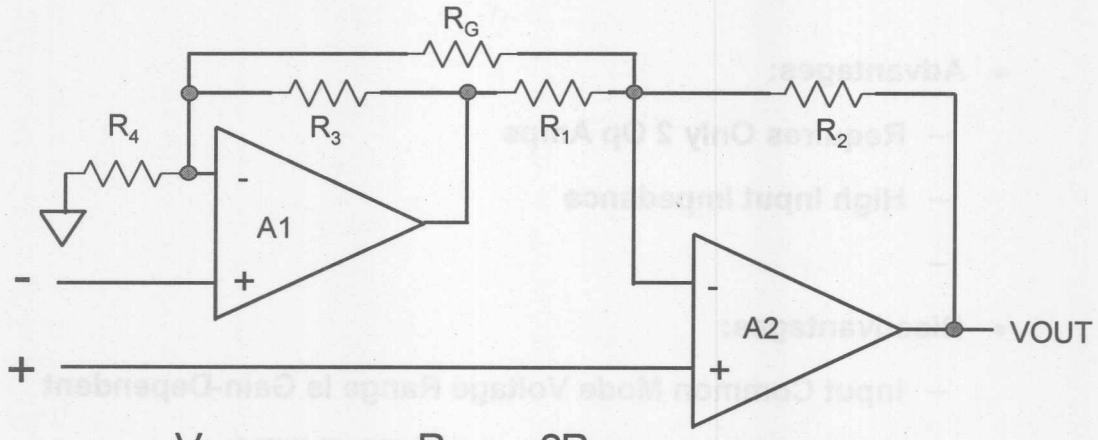
A "Differential" Amplifier



- For Balanced Gain, G = R2/R1 = R2'/R1'
- For Balanced Input Z, R1'+ R2' = R1
- Common Mode Rejection Depends on Resistor Ratio Matching

1-38

2 Op Amp Design



$$\frac{V_{OUT}}{V_{IN}} = 1 + \frac{R_2}{R_1} + \frac{2R_2}{R_G}$$

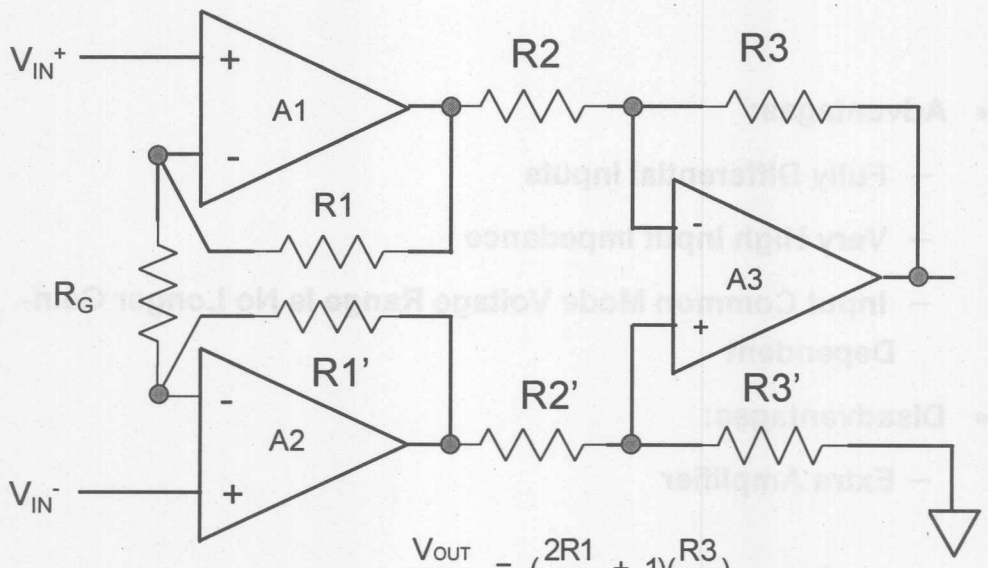
1 - 39

2 Op Amp Design

- **Advantages:**
  - **Requires Only 2 Op Amps**
  - **High Input Impedance**
  - –
- **Disadvantages:**
  - **Input Common Mode Voltage Range Is Gain-Dependent**
  - **A1 Amplifies Common Mode by (R3+R4)/R4**

1 - 40

3 Op Amp Design



$$\frac{V_{OUT}}{V_{IN}} = \left(\frac{2R1}{R_G} + 1\right)\left(\frac{R3}{R2}\right)$$

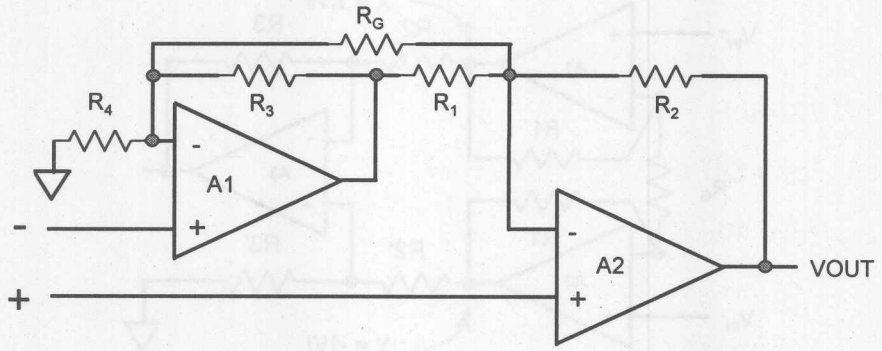
1-41

3 Op Amp Design

- Advantages:
  - Fully Differential Inputs
  - Very High Input Impedance
  - Input Common Mode Voltage Range Is No Longer Gain-Dependent
- Disadvantages:
  - Extra Amplifier

1 - 42

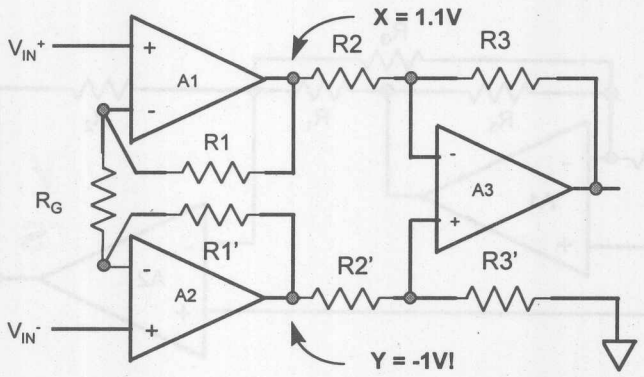
A Discrete Instrumentation Amp using Rail-Rail Op Amps...



- A 2 Op-Amp in-Amp Will Operate on a Single Supply but.....
- A1 Amplifies the Common Mode Voltage. At Low in-Amp Gain, A1 Operates at High Gain. This Limits Input Voltage Range
- A1 and A2 Operate at Different Gains and Therefore Have Different Closed Loop Bandwidths. This Reduces CMMR at Higher Frequencies

1-43

A Discrete Instrumentation Amp using Rail-Rail Op Amps...



- **In an in-Amp Using 3 Precision Single Supply, R/R Op-Amps + Matched R'S, the Input Common-Mode Voltage Range Will Not Be Able to Go to Ground.**
- **As the Common-Mode Voltage Decreases, Internal Node (Y) Will Attempt to Go Below Ground and Will Clamp at the Negative Rail!!!**

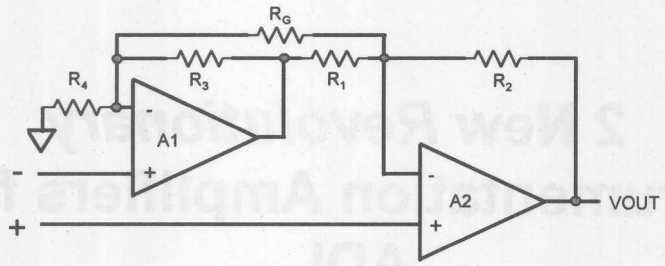
1-44

2 New *Revolutionary* Instrumentation Amplifiers from ADI...

preliminary data

AD627
Micropower, Rail-Rail Instrumentation Amplifier

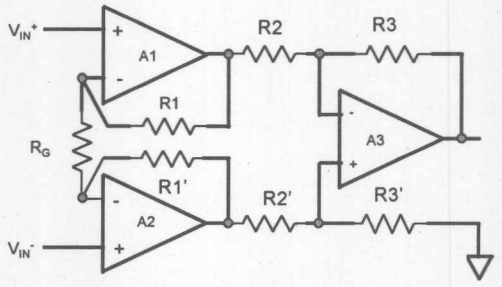
...With Rail-to-Rail Outputs!



- Gain Range : 5-1000
- 80 kHz Bandwidth
- 100 uV Offset Voltage
- 5 nA Input Bias Current
- 53 nV/root Hz RTI Noise (G=5)
- -50mV to + 3.5V CMV Range
- 85 dB CMRR (G=5)
- +3V to ± 15V Supply Options
- 50 uA Supply Current
- 8 Pin DIP, SOIC Packages

1 - 46

AD623
Wideband, Low Cost, Rail-Rail Instrumentation Amplifier



- 800 kHz Bandwidth
- Gain Range : 1-1000
- Rail-to-Rail Output
- 100 uV Max Input Offset ("B")
- 1 uV Max Offset Drift ("B")
- 25 nA Max Input Bias Current
- -150mV to + 3.5V CMV Range
- > 90 dB CMRR (G=10)
- 37 nV/root Hz RTI Noise (G=5)
- +3V to ± 5V Supply Options
- 575 uA Max Supply Current
- 8 Pin DIP, SOIC , μSOIC Packages

1 - 47

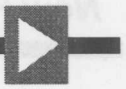
SECTION 2
ANALOG SIGNAL PROCESSING

Variable Gain (Time Gain) Amplifiers (VGAs)

Log Amplifiers

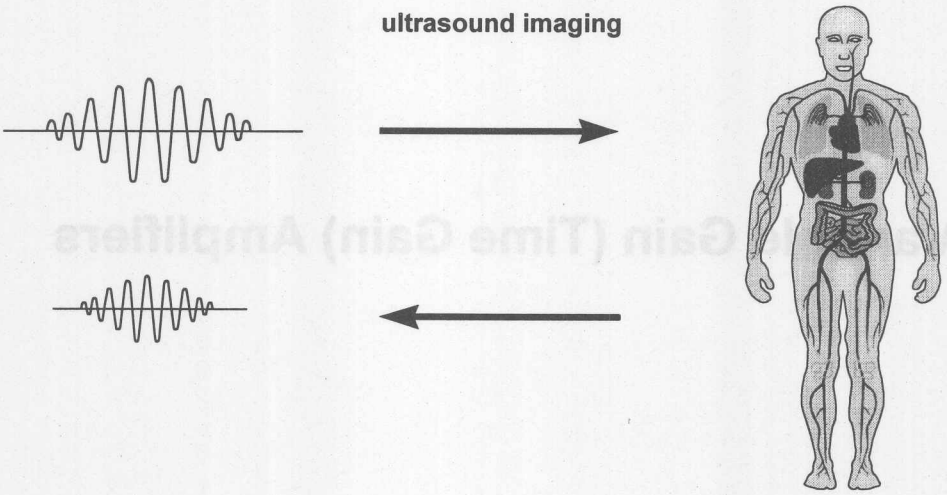
RGB to NTSC/PAL Encoders

Special Functions



Variable Gain (Time Gain) Amplifiers

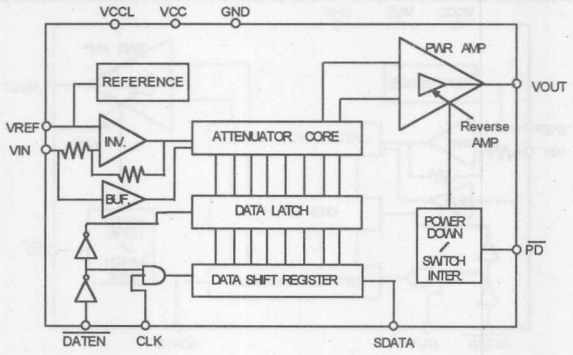
What is Time Gain Amplification?



The gain required to amplify the echo signal at the receiver is proportional to the propagation time of the signal.

2-4

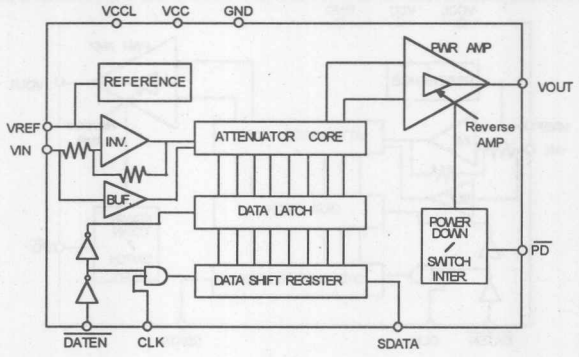
AD8320
Digitally Controlled VGA



- 8 bit Serial Word Provides V/V/LSB Linear Gain Response
- 36 dB Gain Range, ± 0.1dB Gain Accuracy
- DC to 150 MHz Bandwidth
- 1 dB Compression Point : 22 dBm (75 Ω)
- Worst Harmonic Distortion (@ 42 MHz) :
  - - 57 dBc @ 12 dBm Output, - 46 dBm @ 18 dBm Output

2-5

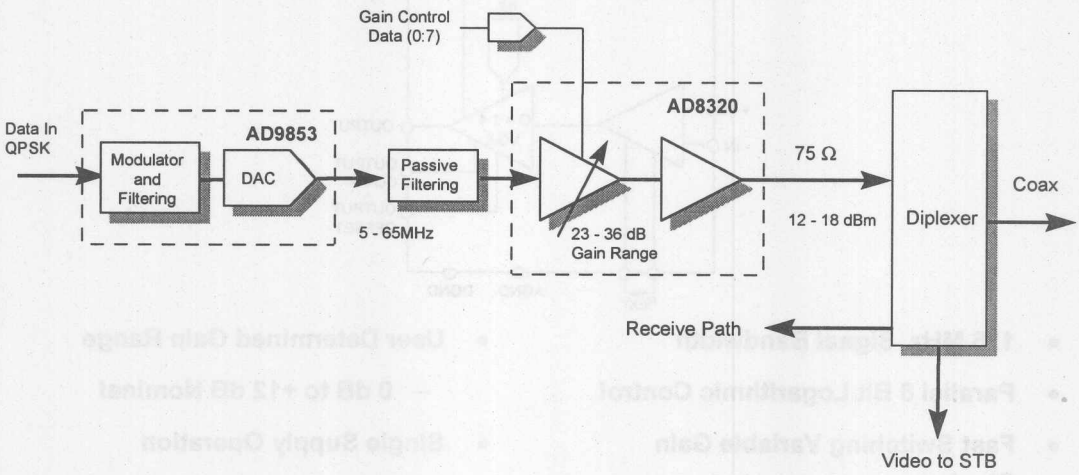
AD8320 - Key Specs and Features (con't)



- **Output Settling to 1 mV : < 30 ns**
- **Single Supply Operation from + 5V to + 12V**
- **Maintains Constant 75 Ω Output During Power Up/Power Down Conditions**
- **SPI™-Compatible Serial Interface**
- **20 Pin SOIC Package**
- **- 40 deg C to + 85 deg C Operation**

2-6

AD8320 in Cable Modems

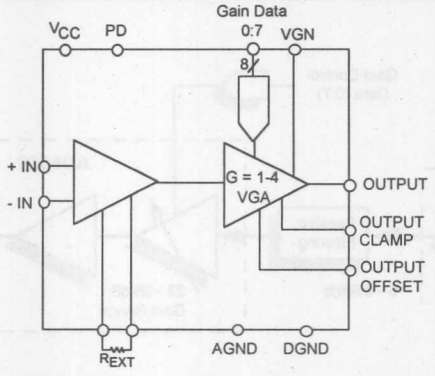


THE AD9853 & AD8320 in an Application for up-Stream Transmit in Subscriber-End Cable Modems

2-7

* Preliminary

AD8325*
Fast Switching Digitally Controlled VGA



- 125 MHz Signal Bandwidth
- Parallel 8 Bit Logarithmic Control
- Fast Switching Variable Gain Block
  - 20 ns Gain Response Time
  - 25 ns Settling Time to 0.1
- User Determined Gain Range
  - 0 dB to +12 dB Nominal
- Single Supply Operation
- Low Power: Isupply of 18 mA
- Power Down to 500 uA

2-8

Log Amplifiers

Analog Devices Introduces 3 New Lost Cost, High Speed Log Amplifiers...

- *AD8306 Demodulating Log Amplifier with Limiter*
- *AD8307 Low Cost RSSI Log Amplifier*
- *AD8309 Low Cost RSSI Log Amplifier w/Limiter*

* Preliminary

AD8306*
350 MHz, 95 dB Demodulating Log Amp with Limiter

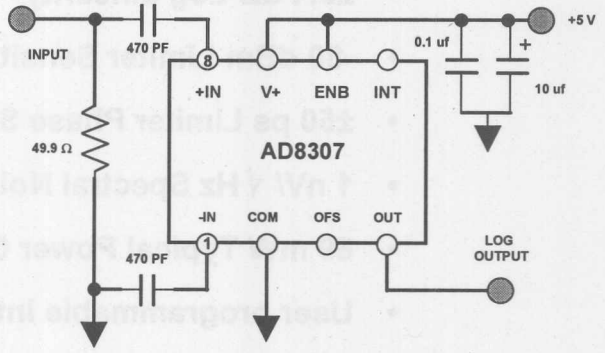
- Usable to 350 MHz
- -80 dBm to +15 dBm Dynamic Range
- ±0.4 dB Log Linearity
- -80 dBm Limiter Sensitivity
- ±50 ps Limiter Phase Skew
- 1 nV/ √ Hz Spectral Noise Density
- 69 mW Typical Power Consumption
- User programmable Intercept & Slope
- +3V & +5V Single Supply Operation

2 - 11

AD8307
Low Cost , 95 dB RSSI Log Amp

The AD8307 is the industry's first 8 pin SOIC Log Amplifier!The limited number of external components required makes the AD8307 extremely user friendly and easy-to-use.

- **Usable to 500 MHz**
- **-74 dBm to +16 dBm Dynamic Range**
- **±1 dB Log Linearity**
- **1.5 nV/ √ Hz Spectral Noise Density**
- **22.5 mW Typical Power Consumption**
- **User programmable Intercept & Slope**
- **+3V & +5V Single Supply Operation**



2 - 12

* Preliminary

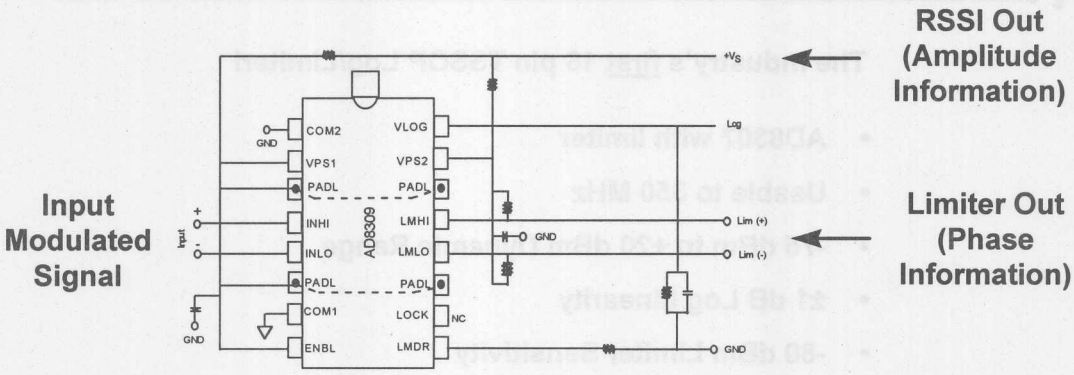
AD8309*
Low Cost, 95 dB RSSI Log Amp with Limiter

The Industry's first 16 pin TSSOP Log/Limiter!

- AD8307 with limiter
- Usable to 350 MHz
- -75 dBm to +20 dBm Dynamic Range
- ±1 dB Log Linearity
- -80 dBm Limiter Sensitivity
- ±100 ps Limiter Phase Skew
- 1 nV/ √ Hz Spectral Noise Density
- 72 mW Typical Power Consumption
- User programmable Intercept & Slope
- +3V & +5V Single Supply Operation

2 - 13

AD8309 - Simplified Diagram

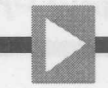


The hard limiter removes the amplitude variation from the input signal giving a square wave out which varies with phase.

Note that the AD8309 has 4 paddle pins which are tied high. These are down-bonded to the paddle to help eliminate package parasitics.

2 - 14

RGB to NTSC/PAL Analog Encoders



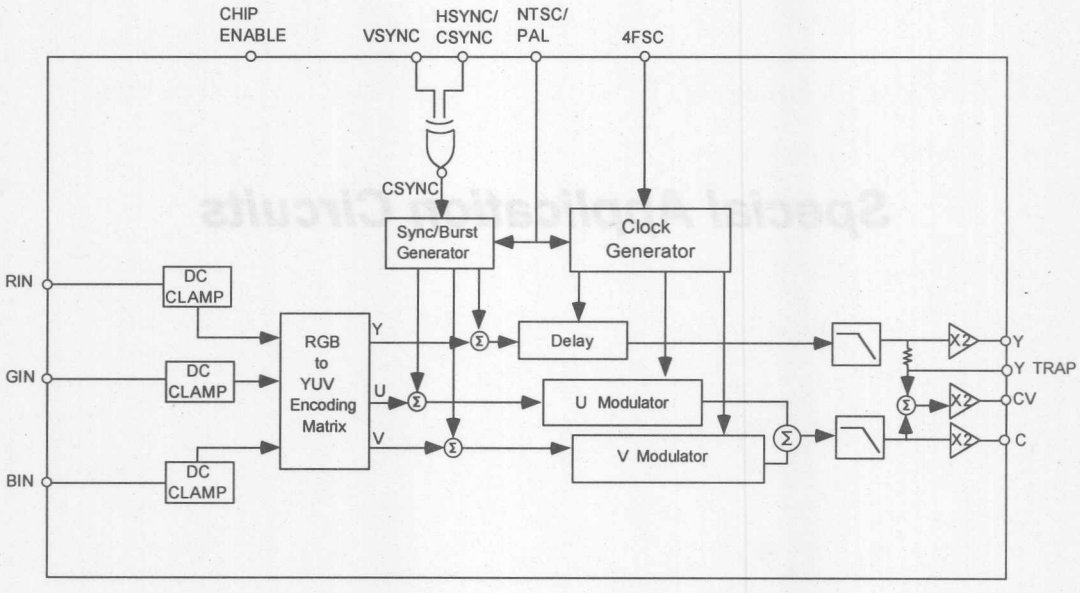
* Preliminary

AD725*
Very Low Cost RGB to NTSC/PAL Encoder

- Complete Solution: No External Filters or Delay Lines Required
- 3V CMOS Logic Levels
- Luma-Trap (notch filter) to Eliminate Cross Color Artifacts
- +5V operation; Powers Down to <100uA
- Pin Out Similar to AD722/AD724, but not Drop-In Replacement:
  - Addition of Luma Trap
  - Removal of On-Chip PLL and Oscillator

2 - 16

AD725 Block Diagram

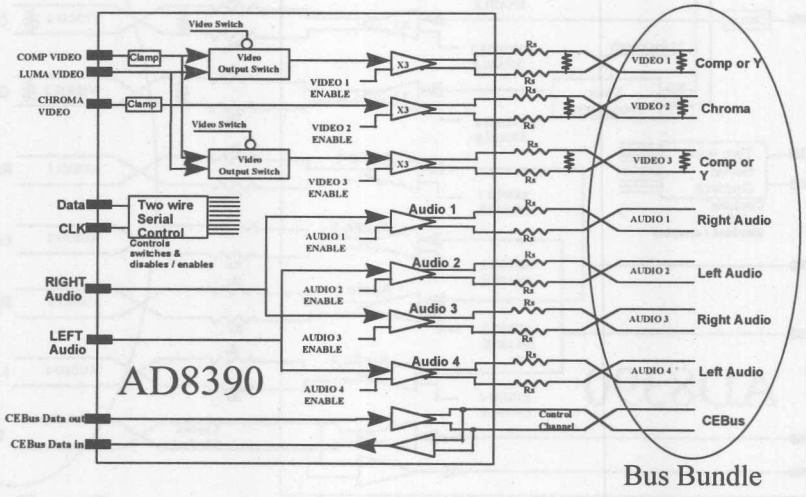


Special Application Circuits

* Preliminary

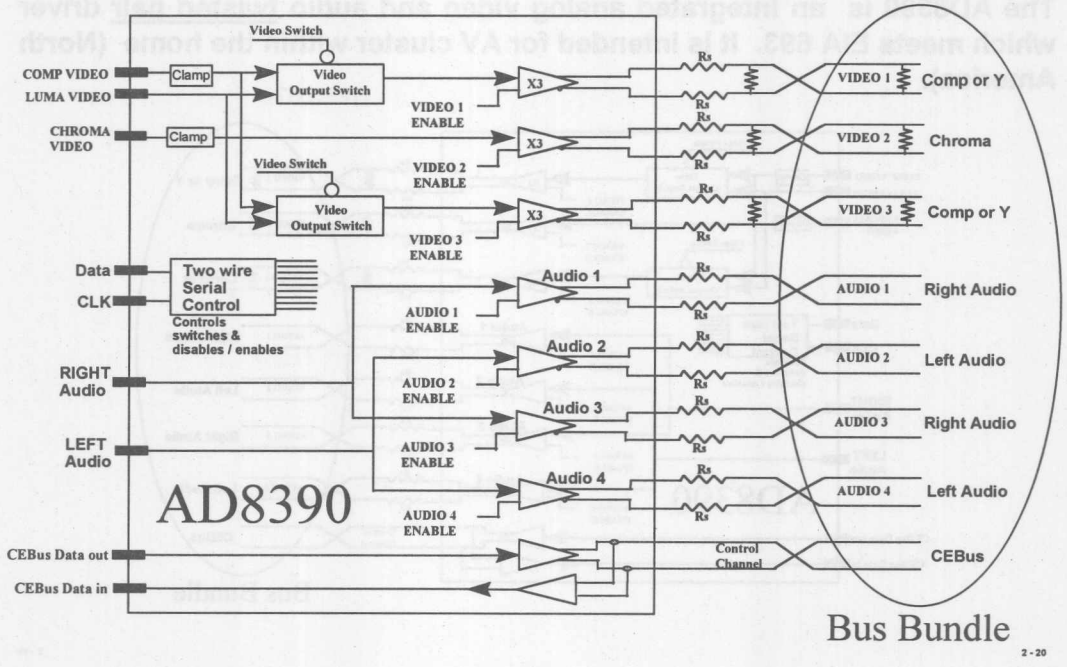
AD8390*
AV Bus Driver Device

The AD8390 is an integrated analog video and audio twisted pair driver which meets EIA 693. It is intended for AV cluster within the home (North America).



2 - 19

AD8390 - AVBus Driver Chip



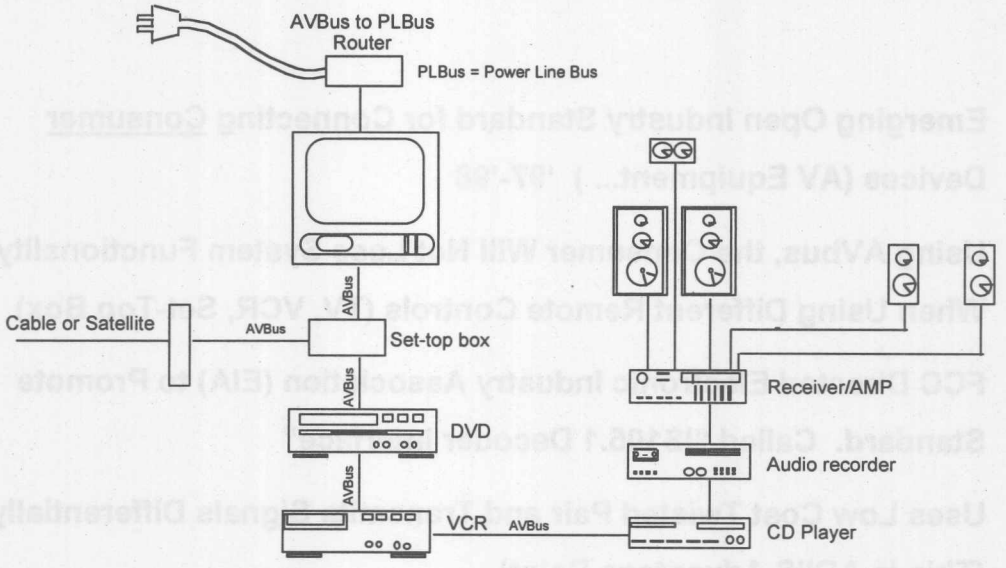
2 - 20

What is AVBus?

- **Emerging Open Industry Standard for Connecting Consumer Devices (AV Equipment...) '97-'98**
- **Using AVbus, the Consumer Will Not Lose System Functionality When Using Different Remote Controls (TV, VCR, Set-Top Box)**
- **FCC Directed Electronic Industry Association (EIA) to Promote Standard. Called "IS105.1 Decoder Interface"**
- **Uses Low Cost Twisted Pair and Transmits Signals Differentially (This Is ADI'S Advantage Point).**

2-21

AD8390 - AVBus System

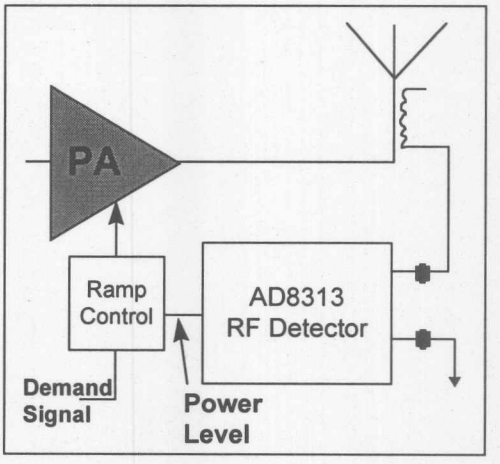


All the major consumer electronics and the cable set-top box manufacturers are participating on the committee to establish the Decoder Interface Standard

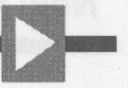
2 - 22

AD8313
0.1 to 2.4GHz, Power Detector

- **Designed to directly measure Tx RF Power. No mix-down required.**
- **Output is log proportional to Tx Power**
- **0.1 to 2.4GHz Input Signal**
- **100ns Response Time**
- **55dB Dynamic Range**
- **+/-1dB Accuracy**
- **+2.7V to +5V Operation, Isy =15mA**



2 - 23



SECTION 3
ANALOG-DIGITAL CONVERTERS

High Speed

Single Supply, Low Power

High Resolution

Voltage - Frequency - Voltage

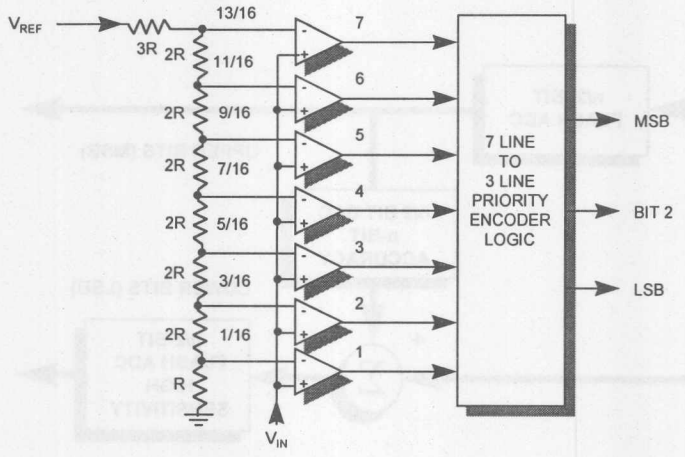
Sigma Delta

Industrial Signal Conditioning

High Speed A/D Converters

What is a "Pipelined" A/D Converter?

A Conventional "Flash" A/D Converter...

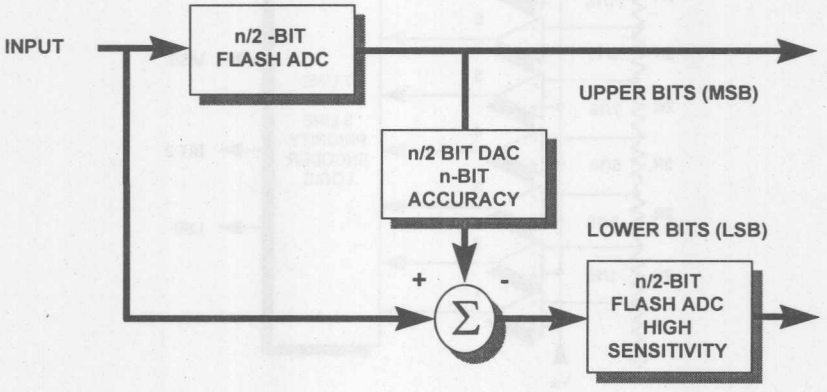


A "flash" converter is generally the fastest converter type, with resolution from 6-8 bits, conversion times <10 ns and no missing codes (why?)

The tradeoff is that a flash converter requires 2^n - 1 resistors and 2^n-1 comparators and is power hungry.

3 - 5

A "Half-Flash" A/D Converter

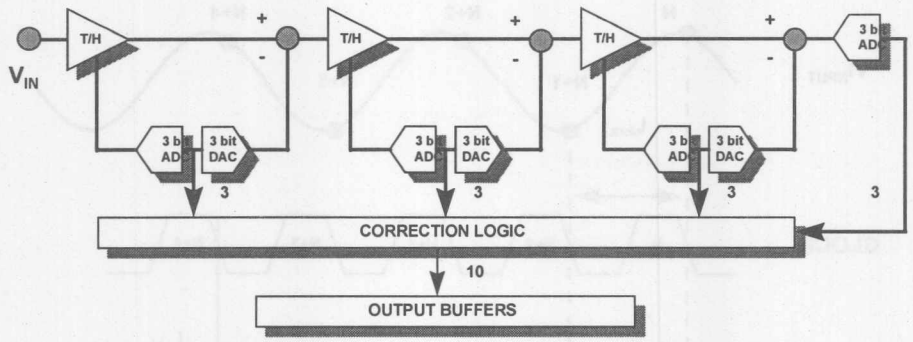


The "half-flash" ADC offers higher resolution than a flash converter, (10-12 bits), has fewer components and generally consumes much less power.

The tradeoff is that the half-flash is slower (< 1 us) and is more complex in its design.

3-6

"Pipelined" or Multi-Stage Architecture...



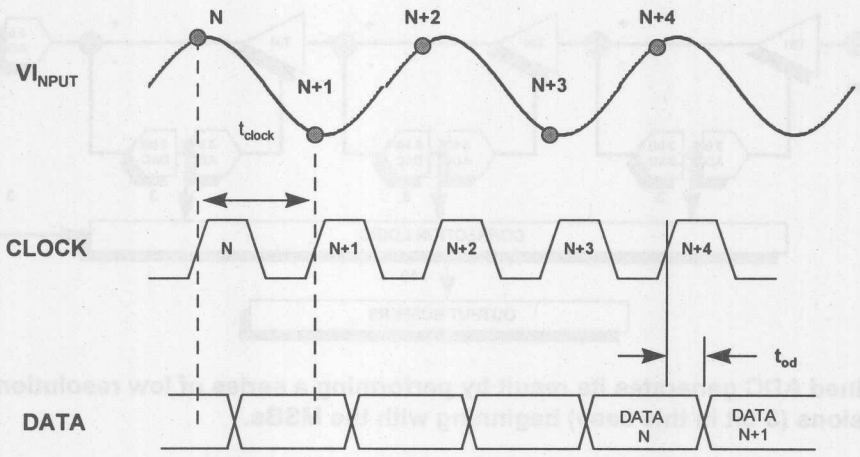
A pipelined ADC generates its result by performing a series of low resolution conversions (3 bit in this case) beginning with the MSBs.

All results generated are subtracted from the original signal (using reconstruction DACs) before the next element in the pipeline (another 3-bit ADC) performs a conversion on the remainder.

The correction logic collects the data, aligns it correctly, uses the extra bits (2 in this case) to perform error correction and outputs a 10-bit result.

3-7

Timing Diagram for a Typical Pipelined A/D Converter



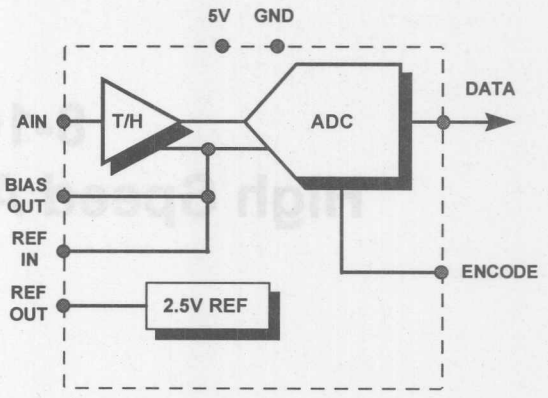
The ADC converts at a high speed (>1MHz) but there is a latency of 4 clock cycles from the start of a conversion to the appearance of the result at the output. The output data rate is, however equal to the clock rate

3-8

8-10 Bit
High Speed A/D Converters

AD9054
8 Bit, 135/200 MSPS A/D Coverter

- Two Speed Versions :
  - AD9054-135 : 135 MSPS
  - AD9054-200 : 200 MSPS
- 350 MHz Analog Input Bandwidth
- Signal to (Noise & Distortion) Ratio (SINAD) @ 200 MSPS :
  - 46 dB @ 49.7 MHz
- Effective Number of Bits (ENOB) @ 200 MSPS :
  - 6.85 typ @ 49.7 MHz
- No Missing Codes Guaranteed
- Low Power : + 5V @ 500 mW



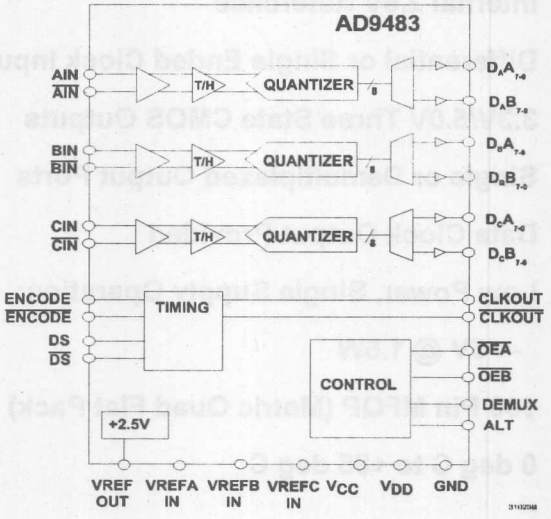
AD9054

3 - 10

*Preliminary Information

AD9483*
Triple 8 Bit, 135 MSPS A/D Converter

The AD9483 is design-optimized for digitizing RGB (Red-Green-Blue) graphics signals from personal computers and workstations with displays up to 1280 x 1024 @ 75 Hz.



AD9483 - Key Specs and Features

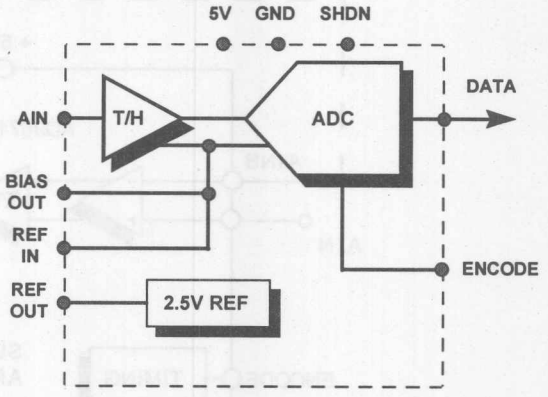
- 300 MHz Analog Input Bandwidth
- 1V p-p Analog Input Range
- Internal 2.5V Reference
- Differential or Single Ended Clock Input
- 3.3V/5.0V Three State CMOS Outputs
- Single or Demultiplexed Output Ports
- Data Clock Output Provided
- Low Power, Single Supply Operation:
  - 5V @ 1.5W
- 100 Pin MFQP (Metric Quad Flat Pack)
- 0 deg C to +85 deg C

3-12

AD9057
8 Bit, 40/60/80 MSPS A/D Converter

The AD9057 has been enhanced to provide 3 performance ranges

- 120 MHz Analog Bandwidth
- 1V p-p Analog Input Range
- Dynamic Performance (@ F_{IN} = 76 MHz)
  - Signal-Noise Ratio : 45 dB typ
  - ENOB : 7.0 typ
- TTL/CMOS-Compatible ENCODE Input
- Digital Outputs from + 5V or + 3V Logic
- Single + 5V Supply Operation
- Low Power Consumption :
  - Normal Mode : 200 mW typical
  - Power Down Mode : < 10 mW
- 20 Pin SSOP Package
- - 40 deg C to + 85 deg C Operation



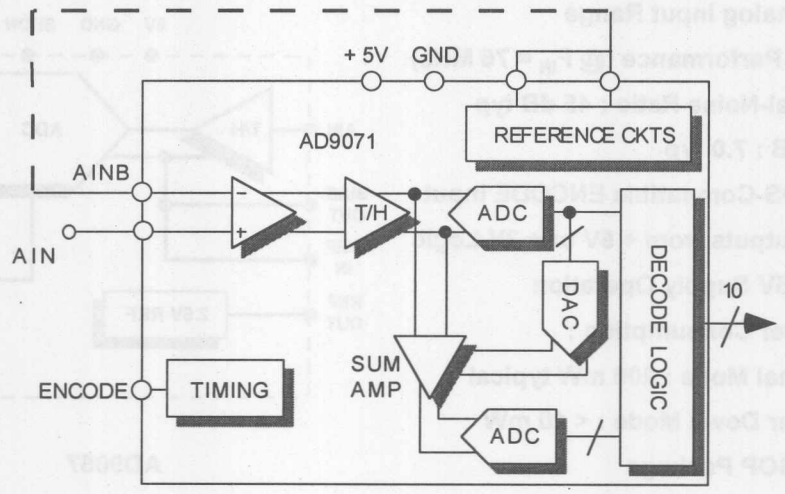
AD9057

3-13

*Preliminary Information

AD9070, AD9071*
10 Bit, 100 MSPS Sampling A/D Converters

The AD9070 and AD9071 offer outstanding performance at sampling rates up to 100 MSPS!



3-14

AD9070, AD9071 - Key Specs and Features

- ECL/PECL (AD9070) or TTL (AD9071) Logic
- 230 MHz Analog Input Bandwidth
- 1V p-p Differential Analog Input
- Signal to (Noise & Distortion) @ 10.3 MHz : 56 dB
- Effective Number of Bits (ENOB) @ 10.3 MHz : 9.2
- Intermodulation Distortion : 70 dBc
- Differential ENCODE Inputs (AD9070)

AD9070, AD9071 - Key Specs and Features (con't)

- **Single Supply Operation:**
  - **AD9070 : - 5V (+5V in PECL mode)**
  - **AD9071 : + 5V**
- **Low Power : 600 mW typ @ 100 MSPS**
- **Out-of-Range Indicator (except AD9070 SOIC)**
- **Packages :**
  - **SOIC : -40 deg C/+85 deg C**
  - **DIP : -55 deg C/+125 deg C (AD9070, only)**

3 - 16

* Preliminary Information

AD9050 and AD9051*
10 Bit, 60 MSPS A/D Converters

An enhanced version of our standard AD9050, the AD9050BRS-60, and the new AD9051 will offer Design Engineers the highest level of 10 bit performance available on the market today!

	AD9050BR	AD9050BR-60	AD9051
Throughput Rate (MSPS)	40	60	60
FP Input Bandwidth (MHz)	100	100	50/140[2]
Effective Number of Bits[1]	8.9	8.5	9.3
Signal-Noise Ratio (dB)[1]	55	53	58
2nd Harmonic Distortion (dBc)[1]	-67	-64	-69
Two-Tone Intermod Distortion (IMD), dBc	65	65	65
Power Dissipation (mW)	315	345	250

Note 1 : F_{in} = 10.3 MHz
Note 2 : Bandwidth is selectable

3-17

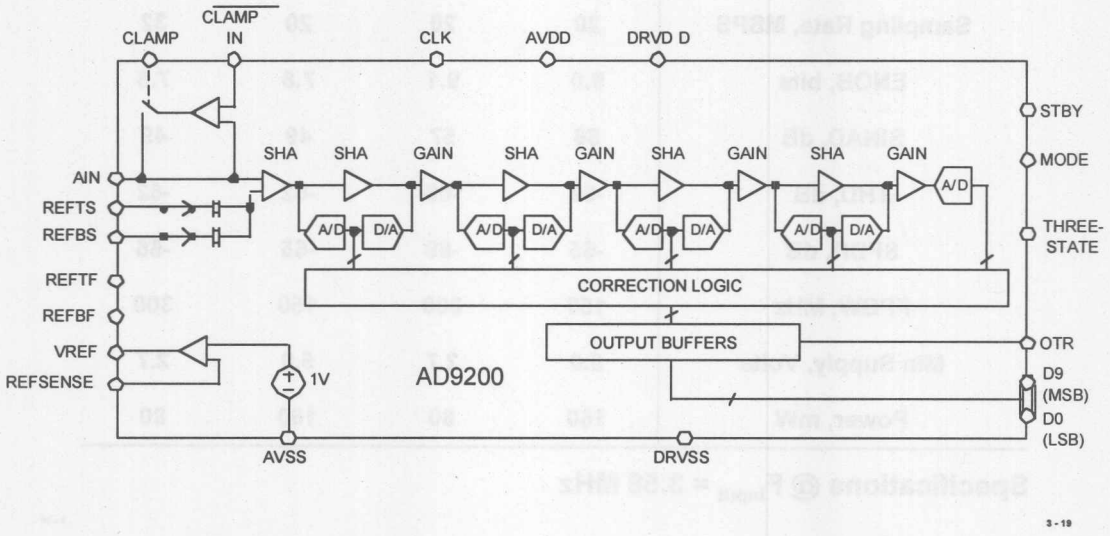
AD9051 - Additional Specs and Features

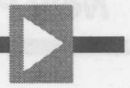
- 60 MSPS Sampling Rate
- 9.3 Effective Number of Bits at fin = 10.3MHz
- 250mW Total Power at 60MSPS
- Selectable Input Bandwidth of 50 or 140 MHz
- On chip T/H and Voltage Reference
- Single +5V Supply Voltage
- Selectable +5V or 3V Logic I/O
- Input Range and Output Coding Options Available

3-18

AD9200 and AD9280
10bit/8 bit Low Power, Sampling A/D Converters

The AD9200 and AD9280 are lower power,next generation upgrades to our popular AD876 10/8 bit, 20 MSPS Sampling A/D Converter





Compare the Performance Between the AD9200, AD9280 and the AD876...

	AD876	AD9200	AD876-8	AD9280
Resolution, bits	10	10	8	8
Sampling Rate, MSPS	20	20	20	32
ENOB, bits	9.0	9.1	7.8	7.8
SINAD, dB	56	57	49	49
THD, dB	-62	-66	-62	-62
SFDR, dB	-65	-69	-65	-66
FPBW, MHz	150	300	150	300
Min Supply, Volts	5.0	2.7	5.0	2.7
Power, mW	160	80	160	80

Specifications @ F_{input} = 3.58 MHz

3-20

AD9200 and AD9280 - Additional Specs/Features

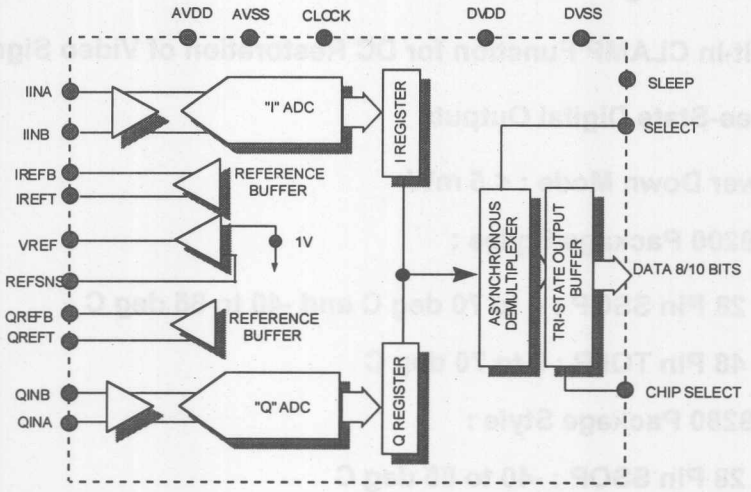
- Adjustable On-Board Reference
- Out-Of-Range Indicator
- Built-In CLAMP Function for DC Restoration of Video Signals
- Three-State Digital Outputs
- Power Down Mode : < 5 mW
- AD9200 Package Styles :
  - 28 Pin SSOP : 0 to 70 deg C and -40 to 85 deg C
  - 48 Pin TQFP : 0 to 70 deg C
- AD9280 Package Style :
  - 28 Pin SSOP : -40 to 85 deg C

3 - 21

Preliminary Information

AD9201* and AD9281*
Dual Channel, 10-bit/8-bit, 20MSPS, A/D Converters

The AD9201 (10 bit) and AD9281 (8 bit) are pin-pin compatible, and are optimized for spurious-free dynamic performance in processing I and Q signals in communications applications



3 - 22

AD9201 and AD9281 - Key Spec and Features

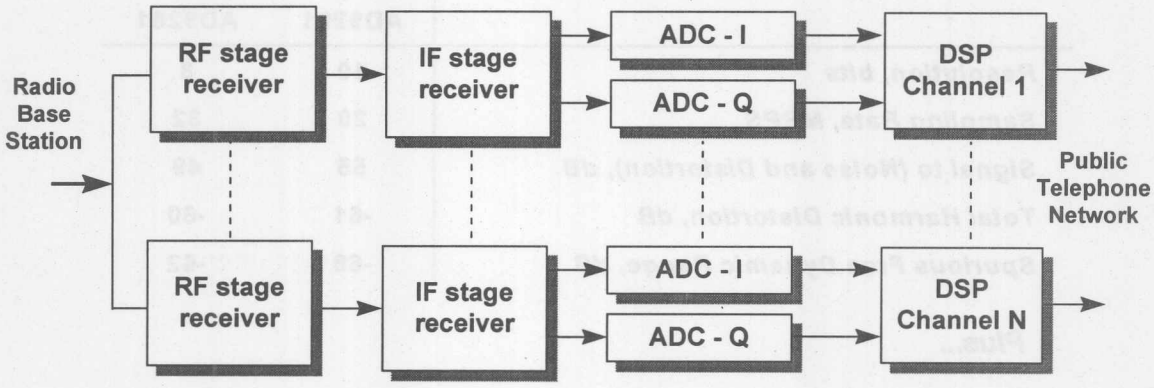
	AD9201	AD9281
Resolution, bits	10	8
Sampling Rate, MSPS	20	32
Signal to (Noise and Distortion), dB	55	49
Total Harmonic Distortion, dB	-61	-60
Spurious Free Dynamic Range, dB	-68	-62

Plus...

- *90 MHz Full Power Bandwidth*
- *Buffered Analog Inputs*
- *Multiplexed Digital Outputs*
- *2.7V to 5.5V Operation*
- *< 100 mW @ 3V*
- *28 Pin SSOP Package*

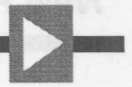
3 - 23

Dual ADCs in Traditional Base Receiver Architecture



- Application: I&Q and Diversity Channels
  - I&Q Requires good Gain and Phase Matching for Demodulation
  - AD9281/01 Multiplexed Data Latches Allow Small Packaging while Supporting Synchronous Clocking of Dual Converters.

3-24



12 Bit
High Speed A/D Converters

Preliminary Information

AD9224 and AD9225
12 Bit, High Speed A-D Converters

The AD9224 and AD9225 represent ADI's next generation of high speed, single supply, 12 bit CMOS ADC's, that feature an impressive 12 bit performance!

	AD9224	AD9225
Throughput Rate (MSPS)	40	25
FP Input Bandwidth (MHz)	250	160
Signal to (Noise & Distortion) (dB) [1]	63	68
Total Harmonic Distortion (dB) [1]	-65	-75
Spurious-Free Dynamic Range (dB) [1]	-65	-80
Power Dissipation (mW)	390	300

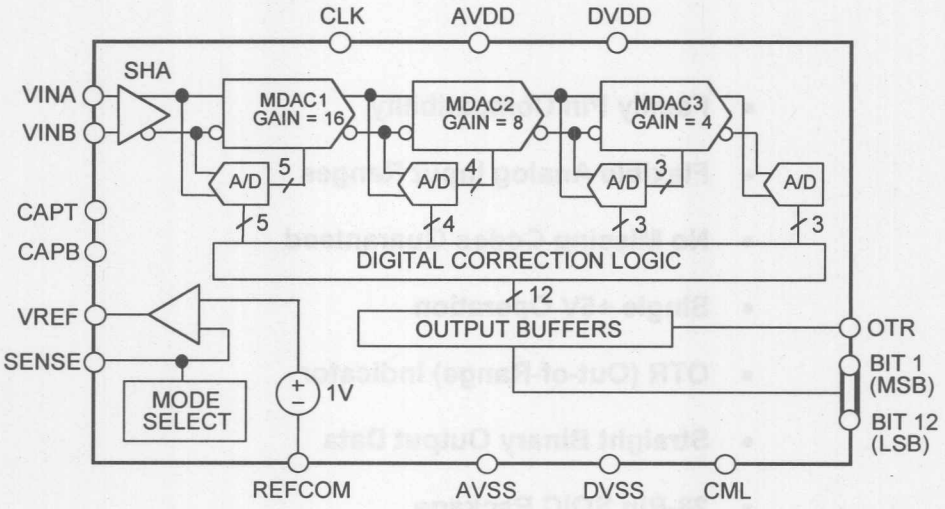
Note 1 : Measured @ F_s = 12.5 MHz

3-26

AD9224 and AD9225 - Additional Specs and Features...

- Family Pin Compatibility
- Flexible Analog Input Ranges
- No Missing Codes Guaranteed
- Single +5V Operation
- OTR (Out-of-Range) Indicator
- Straight Binary Output Data
- 28-Pin SOIC Package

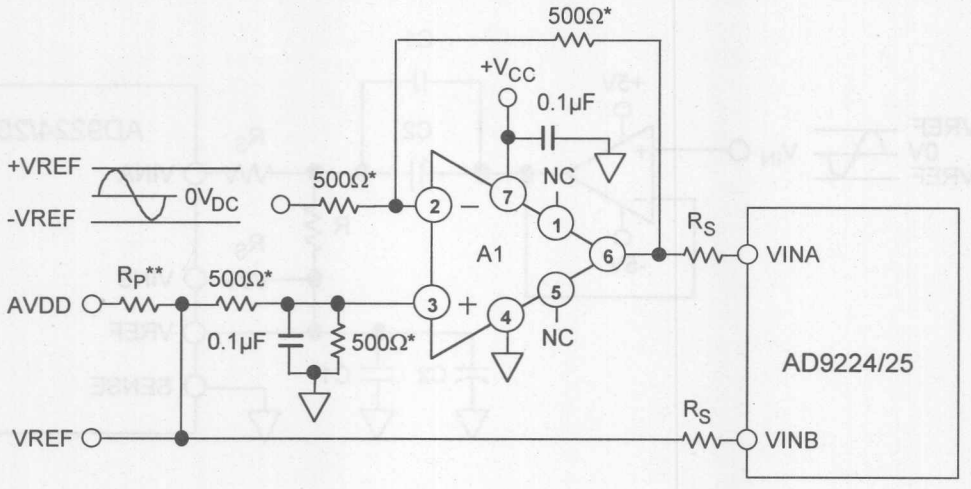
AD9224 and AD9225 - Simplified Diagram



The AD9224 and AD9225 employ a unique, multi-stage "pipelined" architecture with digital output error correction logic to achieve 12-bit accuracy at the specified data rates and to guarantee no missing codes over the full operating temperature range

3-28

Single-Ended Input with DC Coupled Level Shift



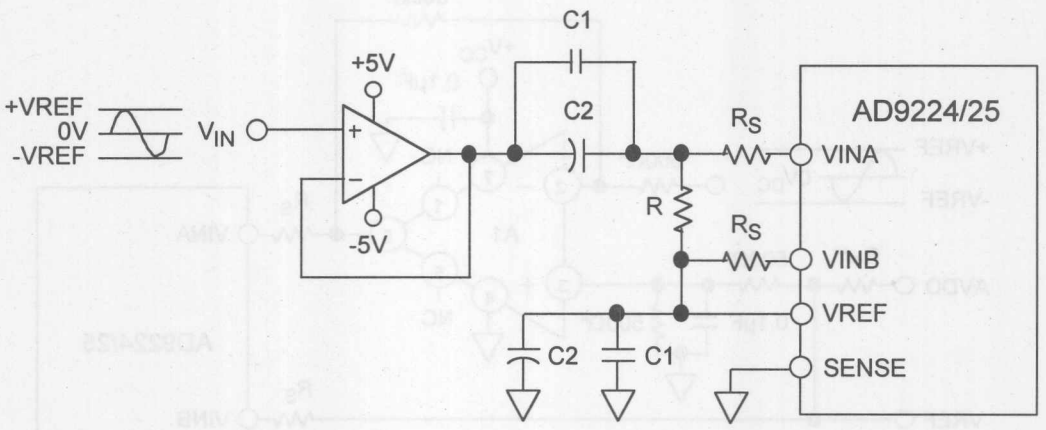
*OPTIONAL RESISTOR NETWORK-OHMTEK ORNA500D

**OPTIONAL PULL-UP RESISTOR WHEN USING INTERNAL REFERENCE

VREF sets the common mode voltage of the AD9224/25. Resistors R_S (100 ohms) provide a balanced input impedance to VINA and VINB.

3 - 29

Single-Ended, AC Coupled Input

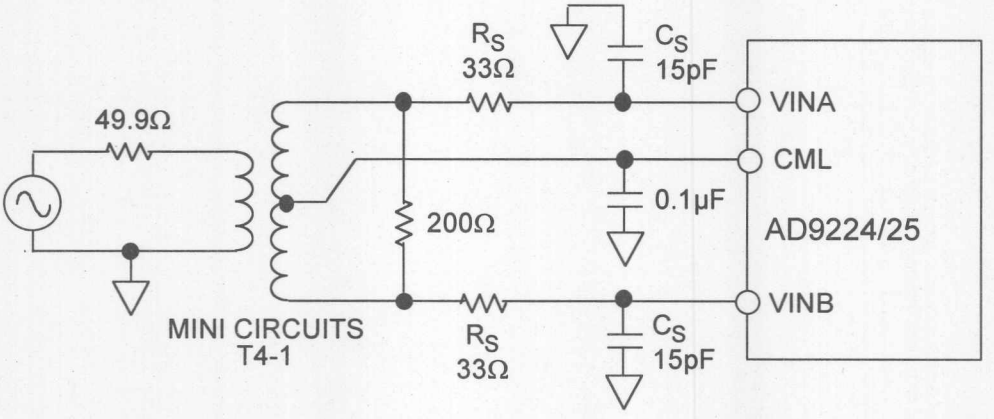


Optimum circuit for noise performance and THD; it provides the ability to use a + 5V or ± 5V op amp.

$$F_{-3dB} = 1/\{2 \times \pi \times R/2 \times (C1 + C2)\}$$

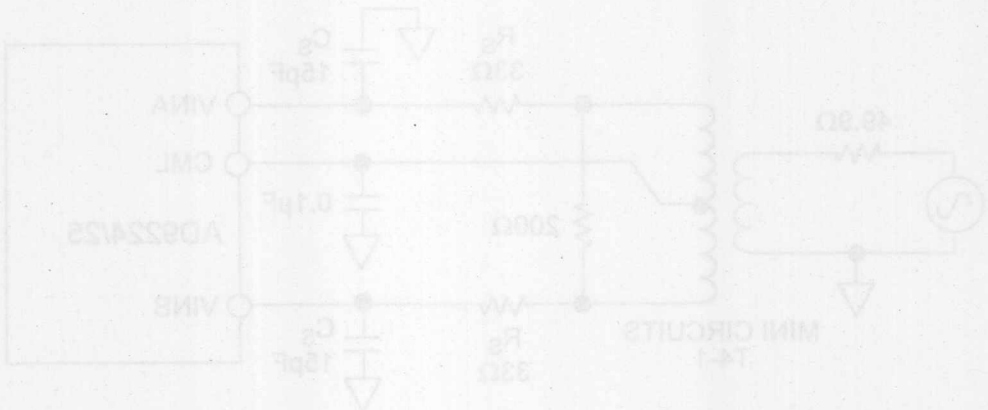
3-30

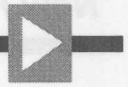
Differential (Transformer-Coupled) Input



Enhanced spectral performance, i.e. improvements in SFDR and SNR

3-31





14-16 Bit
High Speed A/D Converters

2 New High Performance Market Leaders from Analog Devices...

AD9240 - *Fastest* 14 Bit, Monolithic CMOS A/D Converter on the Market.....10 MSPS!

AD9241 - *Lowest Power* 14Bit, 1.25 MSPS A/D Converter on the Market...only 60 mW!

AD9240 and AD9241
14 Bit High Speed A/D Converters

	AD9240	AD9241
Throughput Rate (MSPS)	10	1.25
FP Input Bandwidth (MHz)	70	25
Effective Number of Bits[1]	12.2	12.5
Signal to Noise Ratio (dB)[1]	78.5	79.0
Total Harmonic Distortion (dB)[1]	-77.0	-77.5
Spurious-Free Dynamic Range (dB)[1]	80.0	86.0
Power Dissipation (mW)	285	65

Note 1 : Measured @ $F_s / 2$

3 - 35

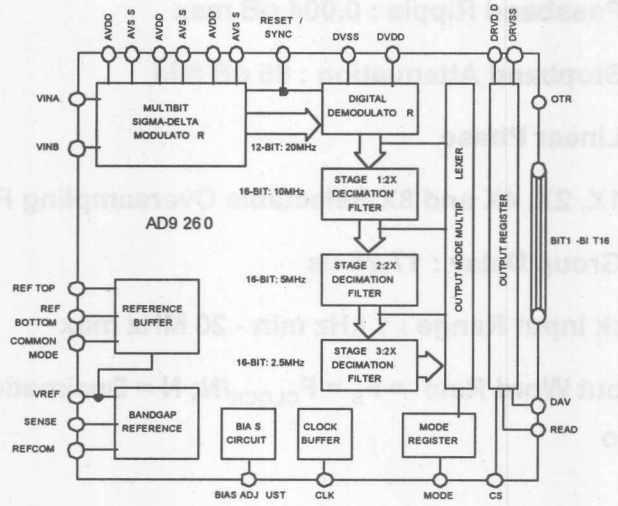
AD9240 and AD9241 (con't)

- Integral Nonlinearity Error : 2.5 LSB
- Differential Nonlinearity Error : 0.6 LSB
- Input Referred Noise : 0.36 LSB
- Out-of-Range Indicator
- Single +5V Supply
- Straight Binary Output Data
- 44 Pin MQFP (Metric Quad Flatpack)

Preliminary Information

AD9260
16 Bit, Oversampling A/D Converter

The AD9260 provides both wide dynamic range *and* high speed with an oversampling ratio of 8X through the use of a *proprietary new technique* which combines the advantages of sigma-delta and pipeline converter technologies!



3-37

AD9260 - Key Specs and Features
(8X Decimation Ratio @ F_{clock} = 20 MHz))

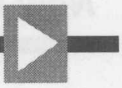
- **High Performance Decimation Filter :**
  - **Passband : 0 min - 1.01 MHz max**
  - **Passband Ripple : 0.004 dB max**
  - **Stopband Attenuation : 85 dB Min**
  - **Linear Phase**
  - **1X, 2X, 4X and 8X Selectable Oversampling Ratios**
  - **Group Delay : 17.25 us**
- **Clock Input Range : 1 kHz min - 20 MHz max**
- **Output Word Rate = $F_S = F_{CLOCK}/N$; N = Decimation Ratio**

3 - 38

AD9260 - Key Specs and Features N = 8(con't)

- Dynamic Performance (F_{IN} = 100 kHz):
  - Signal-to-Noise Ratio : 89 dB
  - Total Harmonic Distortion : -98 dB
  - Spurious-Free Dynamic Range : 100 dB
  - Input Referred Noise : 0.6 dB
- Single +5V Analog Supply, +5V/+3V Digital Supply
  - 550 mW @ 2.5 MHz Data Rate
  - < 150 mW @ Reduced Clock Rates
- Synchronize Capability for Parallel ADC Interface
- Two's Complement Output Format
- 44 Pin MQFP Package

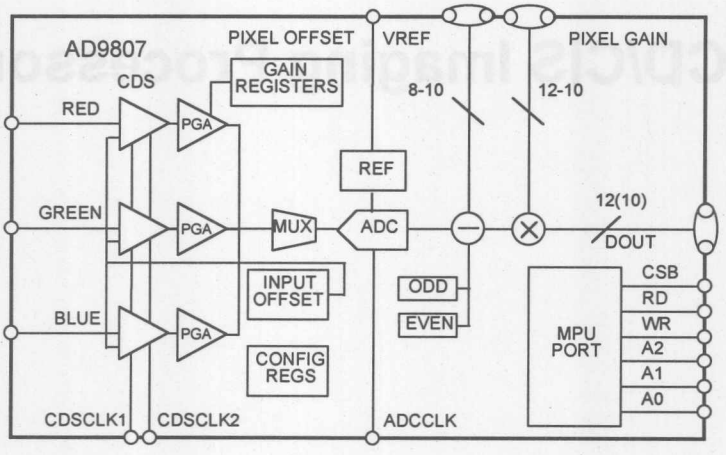
3-39



CCD/CIS Imaging Processors

AD9807 and AD9805
6 MSPS CCD/CIS Signal Processors

The AD9807 (12 bit) and AD9805 (10 bit) are complete, monolithic imaging decoders and signal processor, designed to be AC-coupled directly to the output of a charge coupled device (CCD) or contact image sensor (CIS) output.

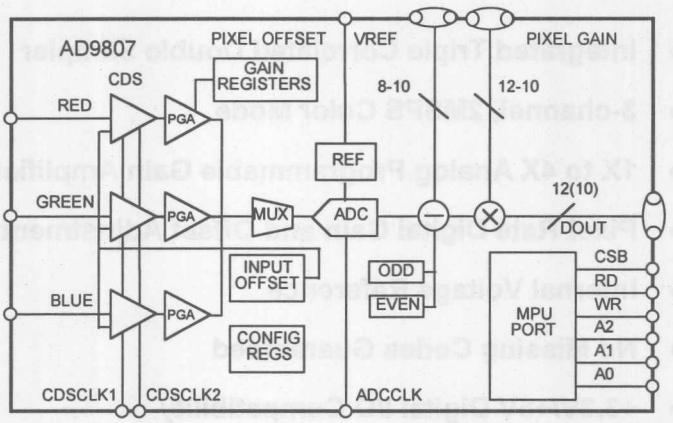


3-42

AD9807, AD9805 - Key Specs and Features

- Integrated Triple Correlated Double Sampler
- 3-channel, 2MSPS Color Mode
- 1X to 4X Analog Programmable Gain Amplifier
- Pixel-Rate Digital Gain and Offset Adjustment
- Internal Voltage Reference
- No Missing Codes Guaranteed
- +3.3V/+5V Digital I/O Compatibility
- Low Power CMOS : 500 mW
- 64 Pin PQFP Surface Mount Package

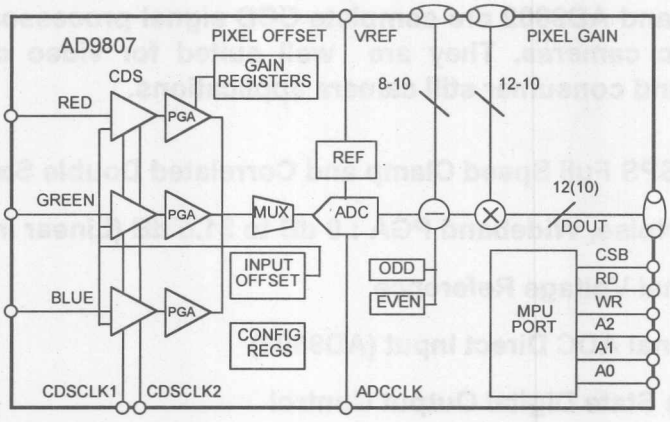
AD9807, AD9805 - Functional Description



The AD9807 and AD9805 include all the circuitry required to perform three-channel correlated double sampling (CDS) and programmable gain adjustment of the CCD or CIS output. An internal 12-bit/10-bit ADC quantizes the signal and passes the digital signal to on-board digital signal processing circuitry which performs pixel rate offset and gain correction.

3-44

AD9807, AD9805 - Functional Description (con't)



This circuitry also corrects odd/even CCD register imbalance errors. The CDS circuitry can be reconfigured as a sample-and-hold for applications that don't require correlated double sampling.

3-45

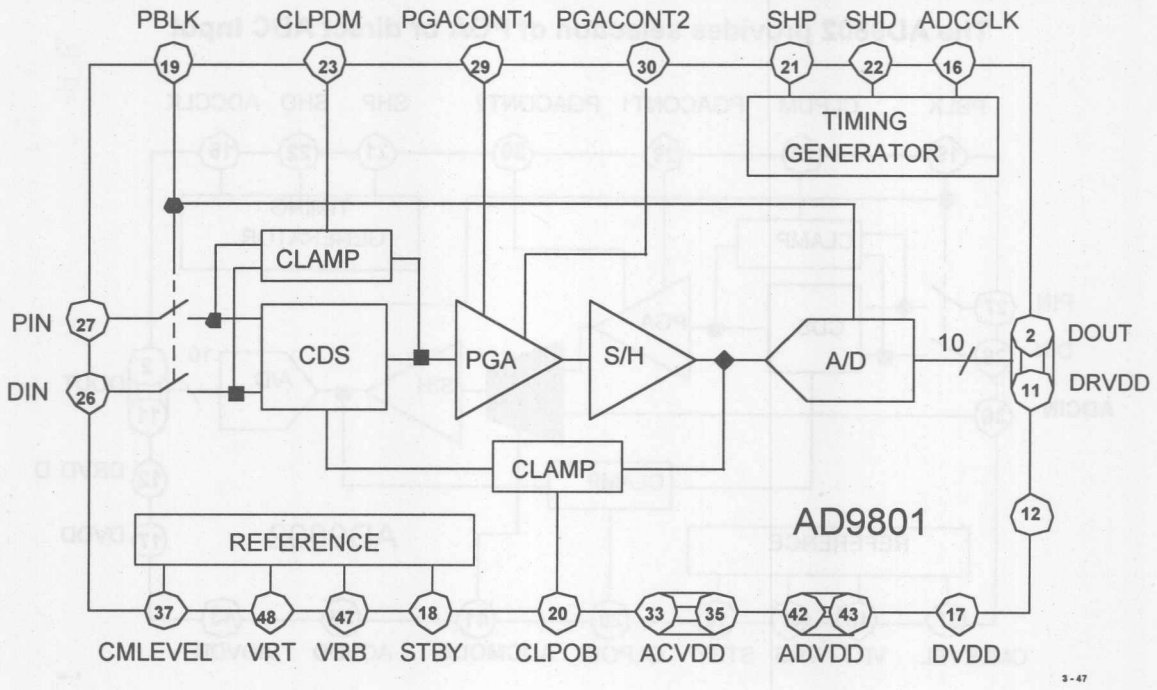
AD9801, AD9802
10 Bit, 18 MSPS CCD Signal Processors

The AD9801 and AD9802 are complete CCD signal processors developed for electronic cameras. They are well suited for video conferencing, camcorder and consumer still camera applications.

- **18 MSPS Full Speed Clamp and Correlated Double Sampler**
- **Low Noise, Wideband PGA : 0 dB to 31.5 dB (Linear in dB)**
- **Internal Voltage Reference**
- **External ADC Direct Input (AD9802)**
- **Three State Digital Output Control**
- **No Missing Codes Guaranteed**
- **+ 3V Single Supply Operation**
- **Low Power CMOS : 185 mW**
- **48 Pin TQFP Package**

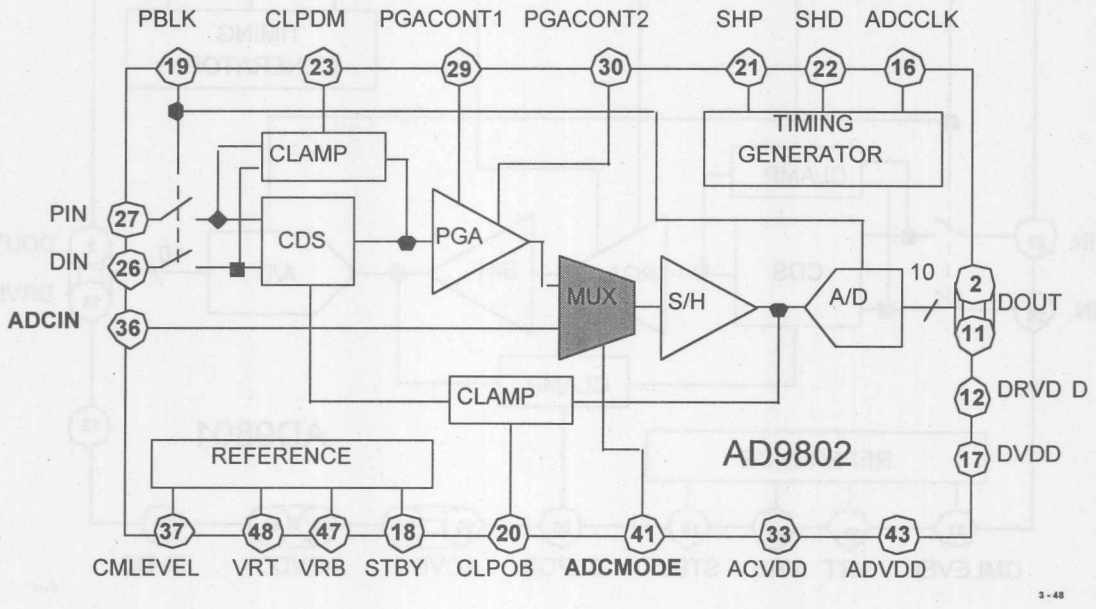
3-46

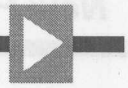
AD9801 - Simplified Diagram



AD9802 - Simplified Diagram

The AD9802 provides selection of PGA or direct ADC Input





Single Supply, Low Power A/D Converters

ANALOG DEVICES Introduces a New Family of 8-12 Bit A/D Converters That Feature a Unique, Proprietary Automatic Power Down Mode...Plus More!

New
8-10 Bit A/D Converters

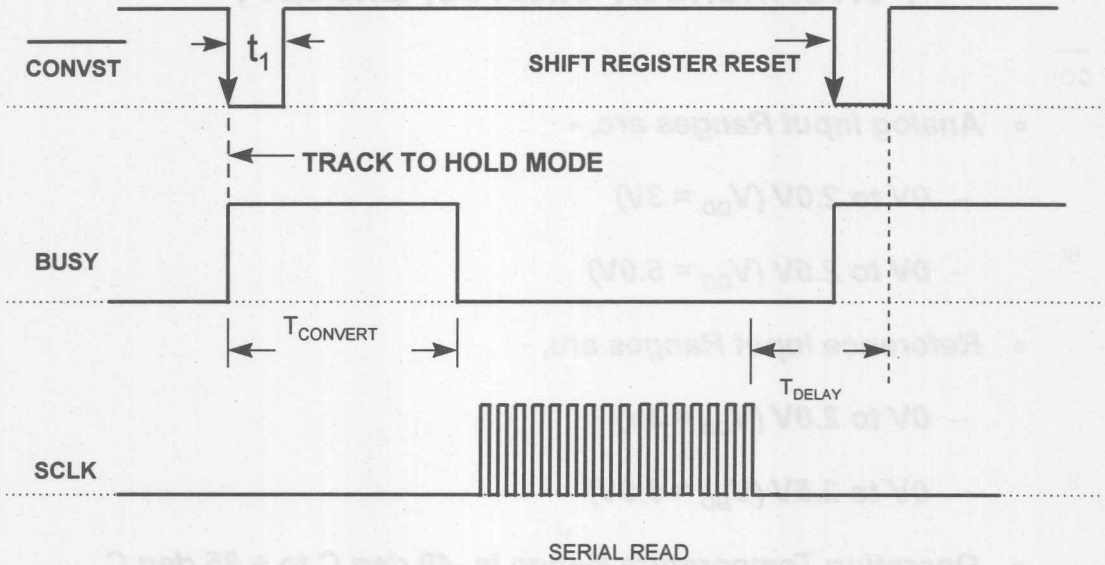
Our New AD781X and AD741X Families of 8-10 Bit ADCs Feature...

- Rail to Rail (0 to V_{DD}) Analog Input Range
- 1.2V to V_{DD} Reference Input Range
- On-Board Reference, Track/Hold and Clock
- Operating Supply Range from 2.7V to 5.5V
- Significant Power Savings via, -
  - Reduction in Throughput Rate
  - Power Down (SLEEP) Between Conversions
- -40/-55 deg C to +105/+125 deg C Temp Ranges

The AD7822/25/27/29 Offer the Same Performance/Features, Except , -

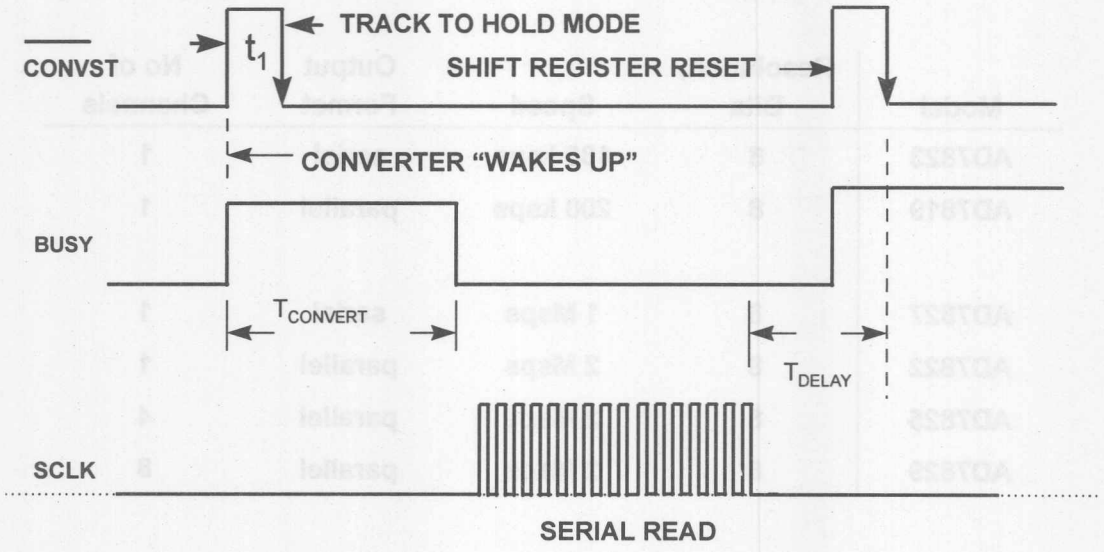
- Analog Input Ranges are, -
  - 0V to 2.0V (V_{DD} = 3V)
  - 0V to 2.5V (V_{DD} = 5.0V)
- Reference Input Ranges are, -
  - 0V to 2.0V (V_{DD} = 3V)
  - 0V to 2.5V (V_{DD} = 5.0V)
- Operating Temperature Range is -40 deg C to + 85 deg C

How Does the Auto Power Down Feature Work?



Normal (High Performance) Mode

Auto Power Down Feature (con't)



Automatic "Sleep" (Power Down) Mode

AD7819 and AD782X Family
8 Bit A/D Converters

Model	Resolution, Bits	Speed	Output Format	No of Channels
AD7823	8	135 ksps	serial	1
AD7819	8	200 ksps	parallel	1
AD7827	8	1 Msps	serial	1
AD7822	8	2 Msps	parallel	1
AD7825	8	2 Msps	parallel	4
AD7829	8	2 Msps	parallel	8

3-56

Preliminary Information

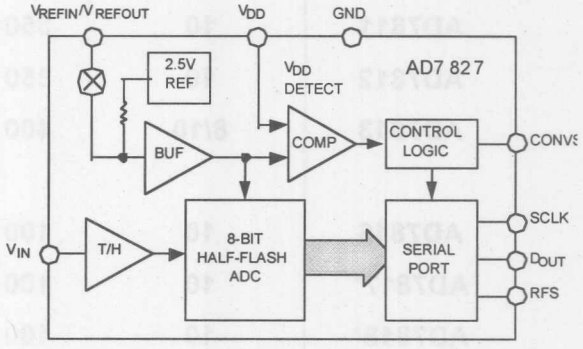
AD781X and AD741X Families
10 Bit A/D Converters

Model	Resolution, Bits	Speed	Output Format	No of Channels
AD7810	10	500 ksps	serial	1
AD7811	10	350 ksps	serial	4
AD7812	10	350 ksps	serial	8
AD7813	8/10	400 ksps	parallel	1
AD7816	10	100 ksps	serial	temp sensor
AD7817*	10	100 ksps	serial	4
AD7818*	10	100 ksps	serial	1
AD7416*	10	100 ksps	I^2C	temp sensor
AD7417*	10	100 ksps	I^2C	4
AD7418*	10	100 ksps	I^2C	1

3 - 57

AD7827
8 Bit, 1 MSPS Serial A/D Converter

- **8-Bit Half-Flash ADC with 420 ns Conversion Time**
- **Analog input Ranges:**
  - **0V to 2 V, V_{DD} = 3V**
  - **0V to 2.5 V, V_{DD} = 5V**
- **Automatic Power Down at End of Conversion**
- **10 mA Normal Mode, 1 uA in Shutdown Mode**
- **8 Pin DIP and SOIC Packages**
- **-40 deg C to +105 deg C**



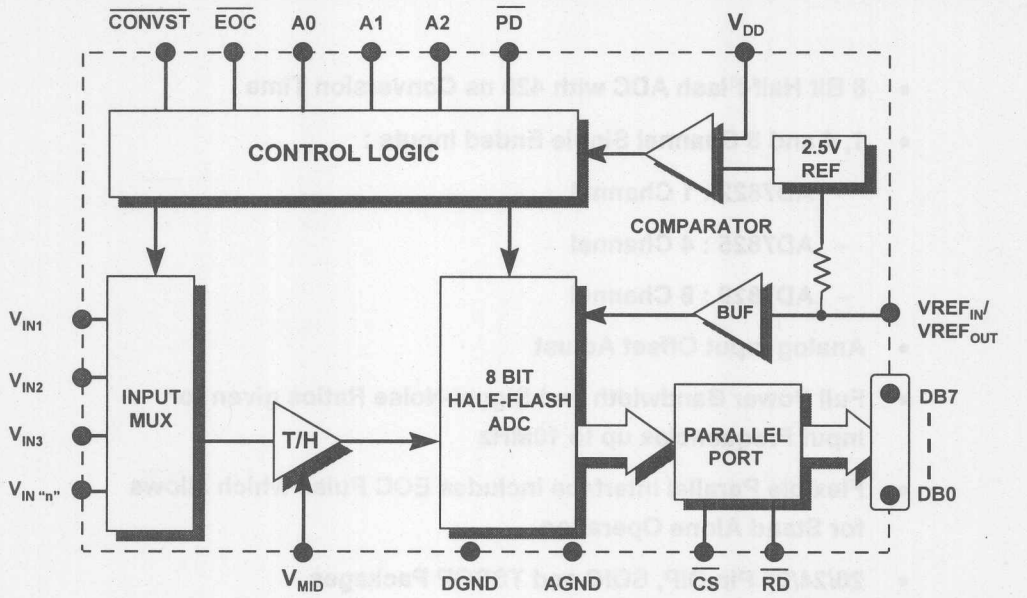
3 - 58

AD7822, AD7825 and AD7829
8 Bit, 2 MSPS Parallel A/D Converters

- 8 Bit Half-Flash ADC with 420 ns Conversion Time
- 1, 4 and 8 Channel Single Ended Inputs :
  - AD7822 : 1 Channel
  - AD7825 : 4 Channel
  - AD7829 : 8 Channel
- Analog Input Offset Adjust
- Full Power Bandwidth and Signal-Noise Ratios given for Input Frequencies up to 10MHz
- Flexible Parallel Interface includes EOC Pulse which allows for Stand Alone Operation
- 20/24/28 Pin DIP, SOIC and TSSOP Packages

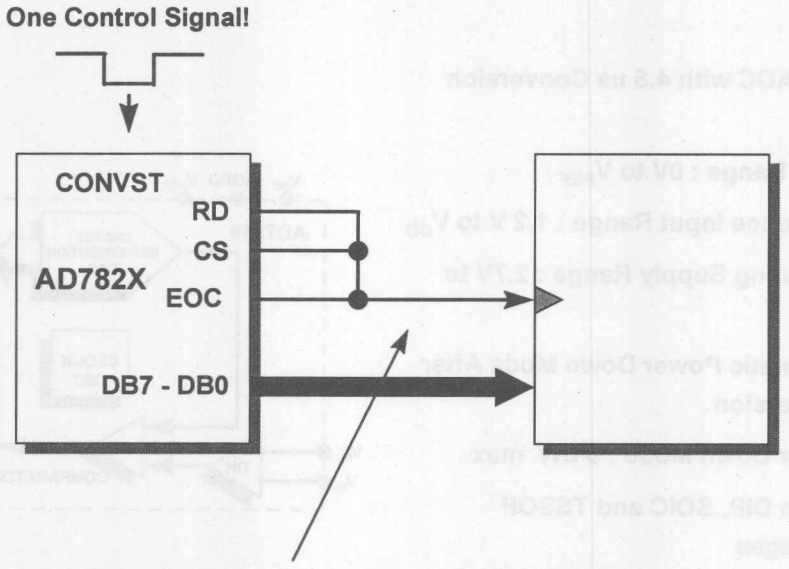
3-59

AD7822/7825/7829 - Simplified Diagram



A0, A1 : AD7825, AD7829
A2 : AD7829
PD : AD7822, AD7825
VIN"N" : AD7825 (4), AD7829 (8) 3-60

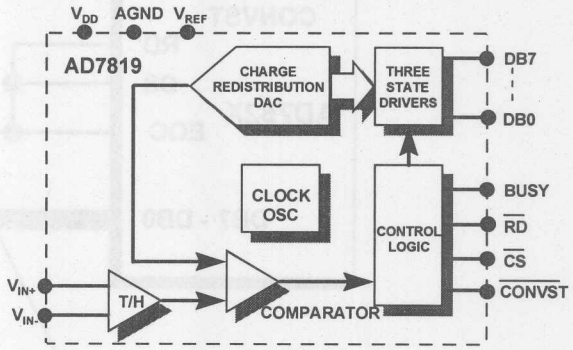
Stand-Alone Operation



3 - 61

AD7819
8 Bit, 200 ksps Parallel A/D Converter

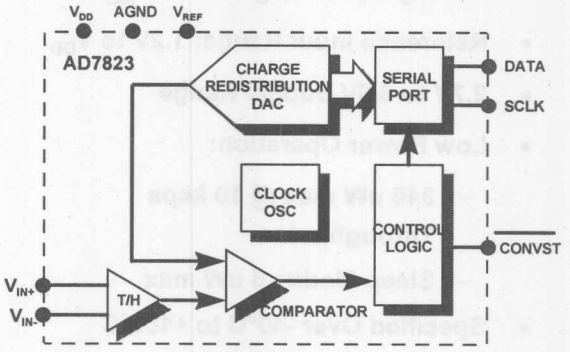
- 8 Bit ADC with 4.5 us Conversion Time
- Input Range : 0V to V_{REF}
- Reference Input Range : 1.2 V to V_{DD}
- Operating Supply Range : 2.7V to 5.5V
- Automatic Power Down Mode After Conversion
- Power Down Mode : 5 uW max
- 16 Pin DIP, SOIC and TSSOP Packages
- -40 deg C to +125 deg C Operation



3 - 62

AD7823
8 Bit, 135 ksps Serial A/D Converter

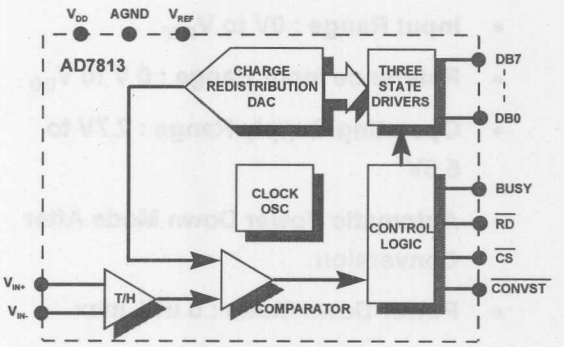
- 8 Bit ADC with 4.5 us Conversion Time
- Input Range : 0V to V_{REF}
- Reference Input Range : 0 V to V_{DD}
- Operating Supply Range : 2.7V to 5.5V
- Automatic Power Down Mode After Conversion
- Power Down Mode : 5 uW max
- 8 Pin DIP, SOIC and MicroSOIC Packages
- -40 deg C to +125 deg C Operation



3 - 63

AD7813
8/10 Bit, 400 ksps Parallel A/D Converter

- 8 Bit Parallel Interface : 8 + 2 Bit Read
- Analog Input Range: 0V to V_{REF}
- Reference Input Range: 1.2V to V_{DD}
- 2.7V to 5.5V Supply Range
- Low Power Operation:
  - 346 uW max @ 10 ksps Throughput
  - Sleep Mode : 5 uW max
- Specified Over -40°C to +105°C
- 16-Lead DIP, SOIC and TSSOP Packages



3 - 64

AD7810, AD7811, AD7812
10 Bit, 500/350 ksps Serial A/D Converters

AD7810 :

- Single Channel Input
- 500 ksps
- 270 uW @ 10 ksps Throughput
- 8-Pin DIP/MicroSOIC Package

AD7811 :

- 350 ksps
- 4 Single Ended Inputs
- 3 Pseudo-Differential Inputs w/Respect to Common
- 2 Independent Pseudo-Differential Inputs
- 525 uW @ 10 ksps Throughput
- 16 Pin DIP, SOIC and TSSOP Packages

AD7812 :

- 350 ksps
- 8 Single Ended Inputs
- 7 Pseudo-Differential Inputs w/Respect to Common
- 4 Independent Pseudo-Differential Inputs
- 525 uW @ 10 ksps Throughput
- 20 Pin DIP, SOIC and TSSOP Packages

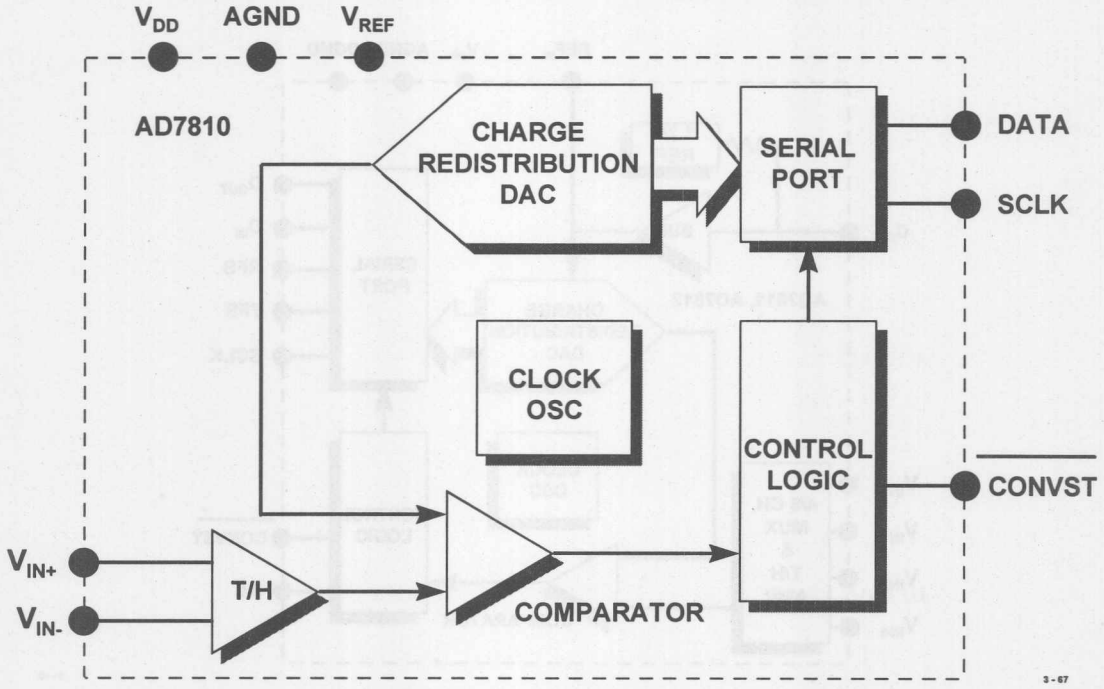
3-65

AD7810, AD7811, AD7812 (con't)

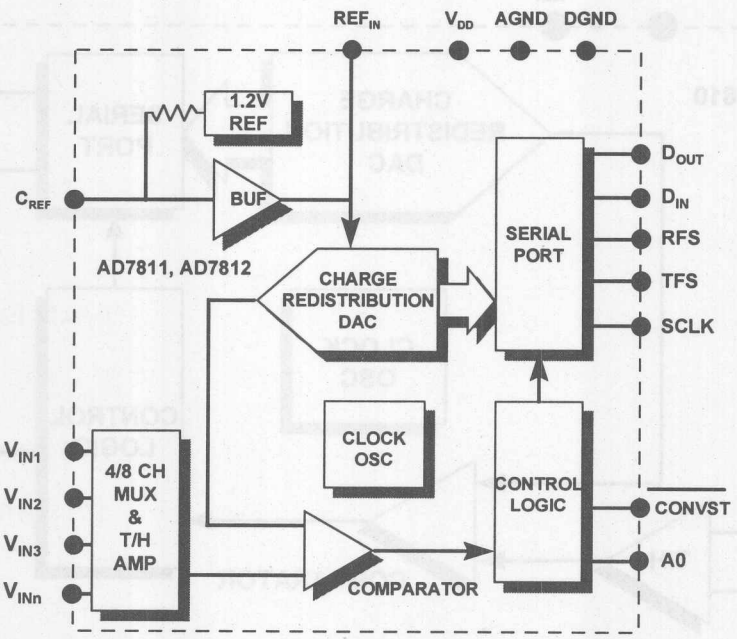
- AD7811 and AD7812 Additional Features:
  - Software Convert Start and Power Down
  - 2 Automatic Power Down Modes
  - Package Address pin (A0) Allows 2 Devices to Share the Same Serial Bus in Multi-Package Applications
- All Models :
  - DSP/ Microcontroller Compatible Serial Interface
  - 5 uW max SLEEP Mode
  - -40 deg C to 105 deg C Operation

3 - 66

AD7810 Block Diagram



AD7811, AD7812 Block Diagram

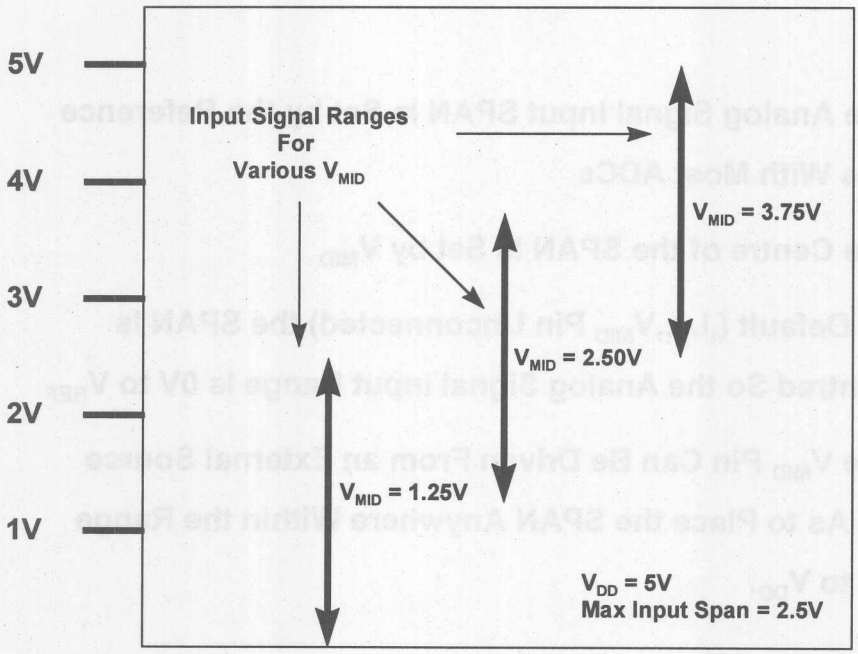


Analog Input Adjustments

- The Analog Signal Input SPAN Is Set by the Reference - As With Most ADCs
- The Centre of the SPAN Is Set by V_{MID}
- By Default (,i.e.,V_{MID} Pin Unconnected) the SPAN Is Centred So the Analog Signal Input Range Is 0V to V_{REF}
- The V_{MID} Pin Can Be Driven From an External Source So As to Place the SPAN Anywhere Within the Range 0V to V_{DD}.

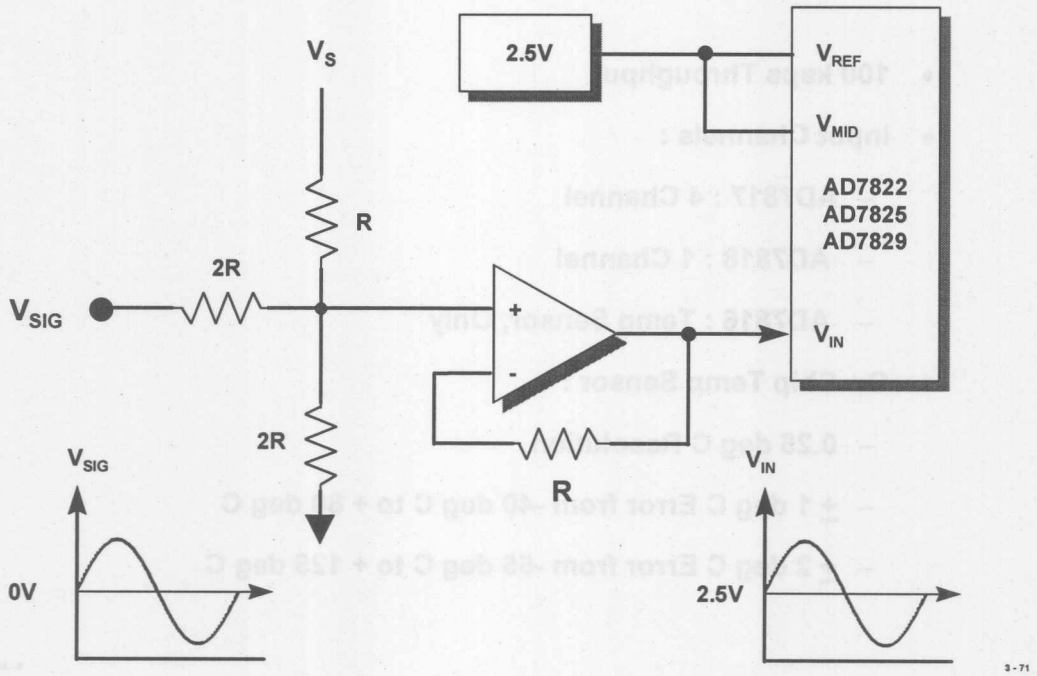
3 - 69

The SPAN Can Be Set Anywhere Within the Range of V_{DD}



3 - 70

How V_{MID} Might Be Used...Accomodating Bipolar Inputs



Preliminary Information

AD7816/AD7817/AD7818
1/4-Channel 10-Bit ADCs w/ On-Board Temp Sensor

- 100 ksps Throughput
- Input Channels :
  - AD7817 : 4 Channel
  - AD7818 : 1 Channel
  - AD7816 : Temp Sensor, Only
- On-Chip Temp Sensor :
  - 0.25 deg C Resolution
  - ± 1 deg C Error from -40 deg C to + 80 deg C
  - ± 2 deg C Error from -55 deg C to + 125 deg C

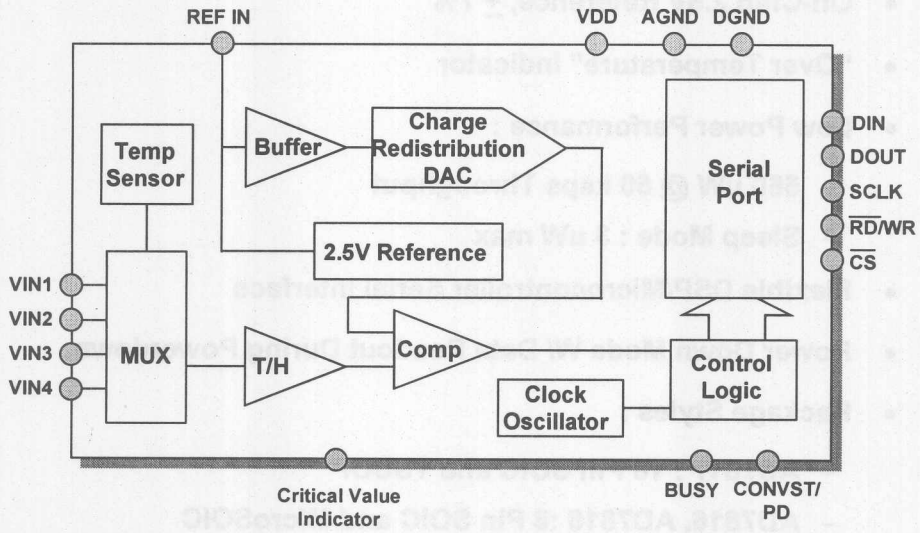
3 - 72

AD7816, AD7817 and AD7818 (con't)

- On-Chip 2.5V Reference, ± 1%
- "Over Temperature" Indicator
- Low Power Performance :
  - 560 uW @ 50 ksps Throughput
  - Sleep Mode : 3 uW max
- Flexible DSP/Microcontroller Serial Interface
- Power Down Mode W/ Data Readout During Powerdown
- Package Styles :
  - AD7817 : 16 Pin SOIC and TSSOP
  - AD7816, AD7818 :8 Pin SOIC and MicroSOIC

3 - 73

AD7817 - Block Diagram

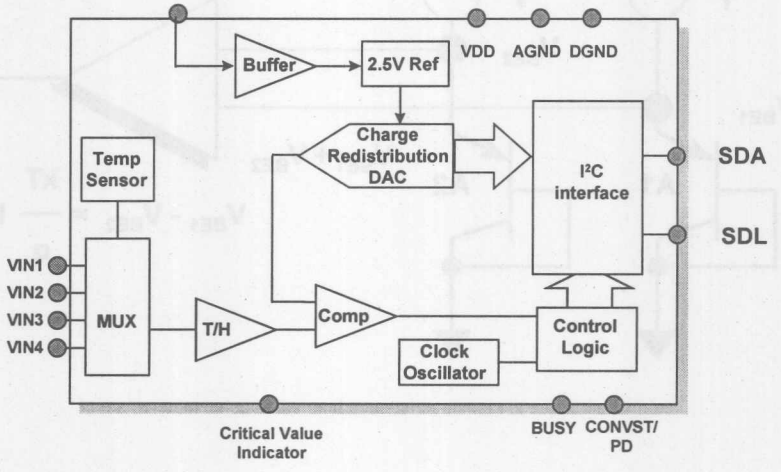


3 - 74

Preliminary Information

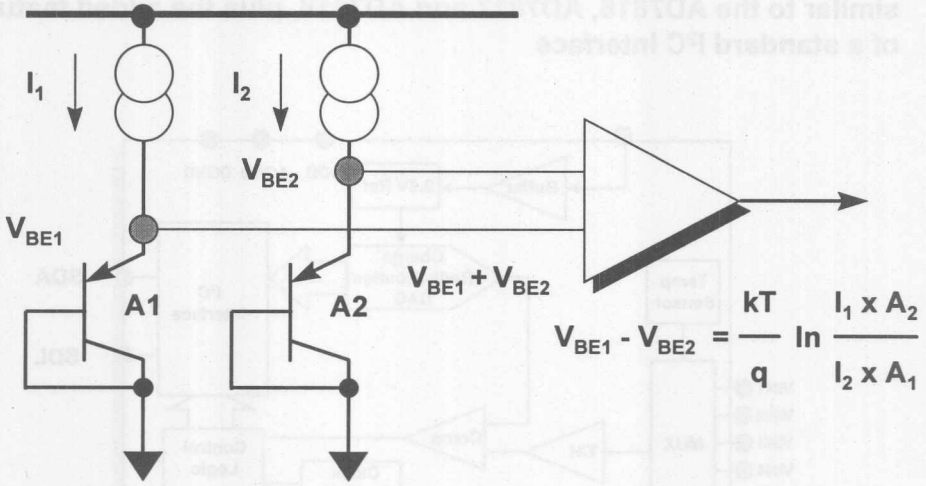
AD7416/AD7417/AD7818
1/4-Channel 10-Bit ADCs w/ On-Board Temp Sensor

The AD7416, AD7417 and AD7418 offer performance and features similar to the AD7816, AD7817 and AD7818, plus the added feature of a standard I²C Interface



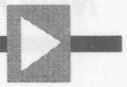
3 - 75

The On-Chip Temperature Sensor



3-76

12 Bit A/D Converters

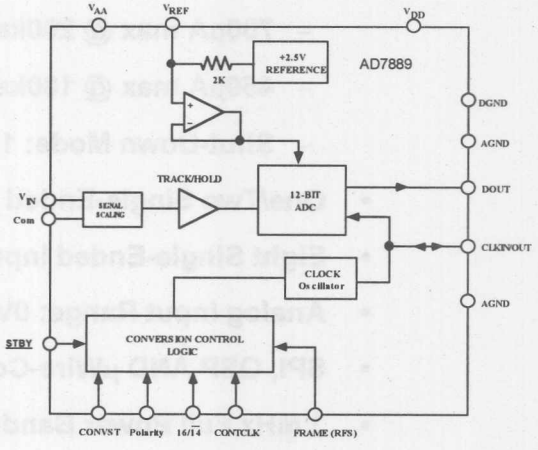


ADI's Family of 12 Bit A/D Converters Feature...

- Wide Selection of Input Ranges :
  - + 2.5V, + 5V, or + 10V
  - ± 2.5V, ± 5V, or ± 10V
- Single +5V Supply Operation
- Power Down or SLEEP mode
- Overvoltage Protection up to ± 20V

AD7889
12 Bit, 600 ksps, Serial A/D Converter

- Fastest 12-Bit Serial ADC
- Single +5V Supply, 90 mW max
- Standby Mode: 75μA typ
- Flexible Serial Clock Options
  - 14/16 Bit Data Stream
  - Self-Clocking/External Clocking
- Selection of Input Ranges
  - +/-10V for AD7889-1
  - +/-2.5V for AD7889-3
  - 0 to +2.5V for AD7889-2
- Overvoltage Protection on AIN
- 16-Pin SSOP Package



3 - 79

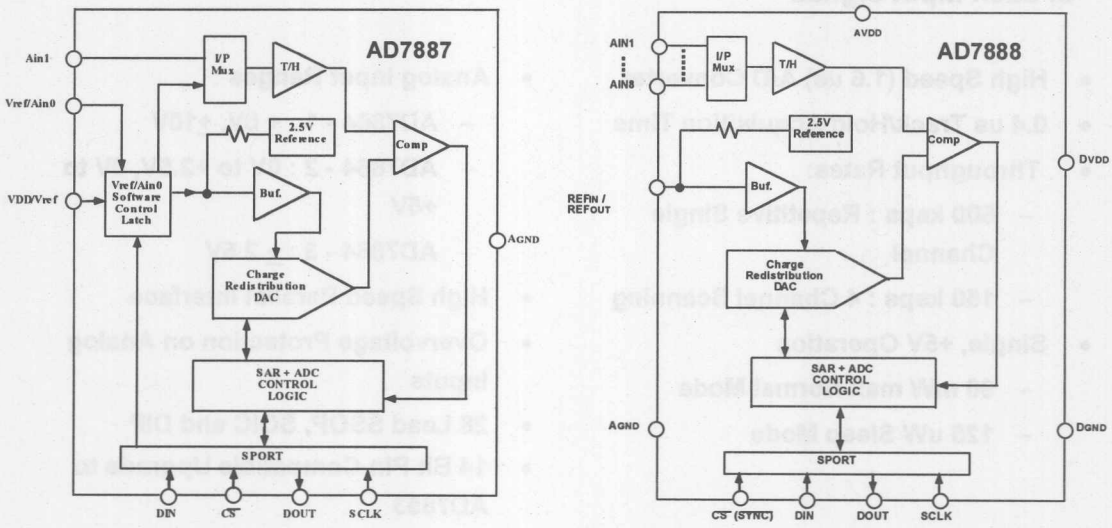
Preliminary Information

AD7887, AD7888
12 Bit, 200 ksps, 2/8 Channel, Serial A/D Converters

- Specified for V_{DD} of 2.7V to 5.25V
  - 700μA max @ 200ksps
  - 450μA max @ 100ksps
  - Shut-Down Mode: 1μA max
- One/Two Single-Ended Inputs (AD7887)
- Eight Single-Ended Inputs (AD7888)
- Analog Input Range: 0V to VREF (VDD)
- SPI, QSP AND μWire-Compatible Serial Interface:
- 3 MHz Full Power Bandwidth
- 8-pin Narrow SOIC and μSOIC Packages (AD7887)
- 16-pin Narrow SOIC and TSSOP Packages (AD7888)

3 - 80

AD7887, AD7888



3 - 81

Preliminary Information

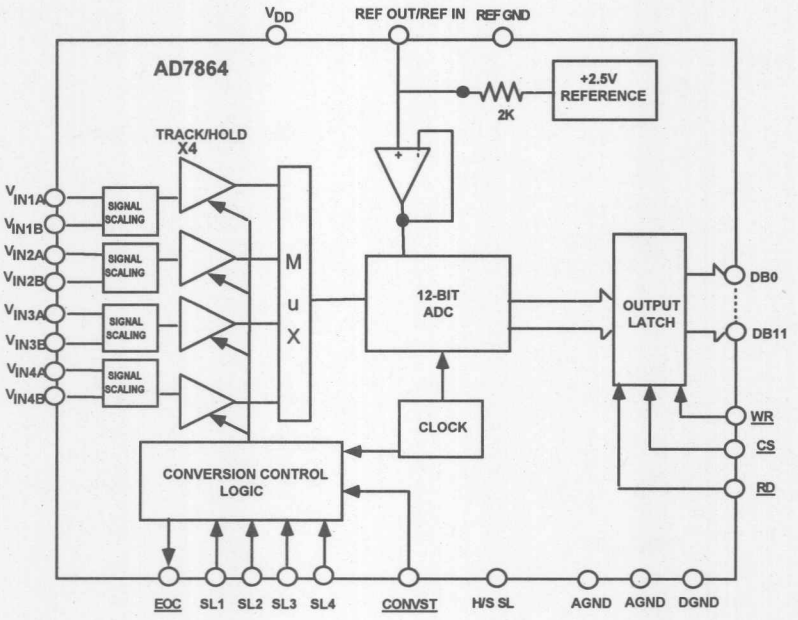
AD7864
12 Bit, 4 Channel, Simultaneous Sampling A/D Converter

Simultaneous sampling preserves the relative phase/timing relationships of each input signal.

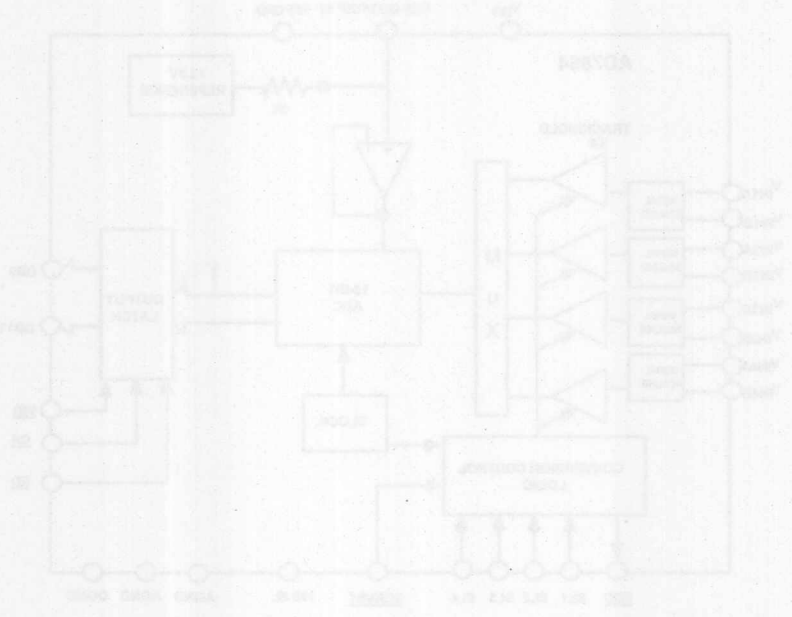
- High Speed (1.6 us) A/D Converter
- 0.4 us Track/Hold Acquisition Time
- Throughput Rates:
  - 500 ksps : Repetitive Single Channel
  - 150 ksps : 4 Channel Scanning
- Single, +5V Operation
  - 90 mW max Normal Mode
  - 125 uW Sleep Mode
- Analog Input Ranges :
  - AD7864 - 1 : ± 5V, ±10V
  - AD7864 - 2 : 0V to +2.5V, 0V to +5V
  - AD7864 - 3 : ± 2.5V
- High Speed Parallel Interface
- Overvoltage Protection on Analog Inputs
- 28 Lead SSOP, SOIC and DIP
- 14 Bit Pin-Compatible Upgrade to AD7853

3 - 82

AD7864 - Block Diagram



3 - 83



14-16 Bit
A/D Converters

Preliminary Information

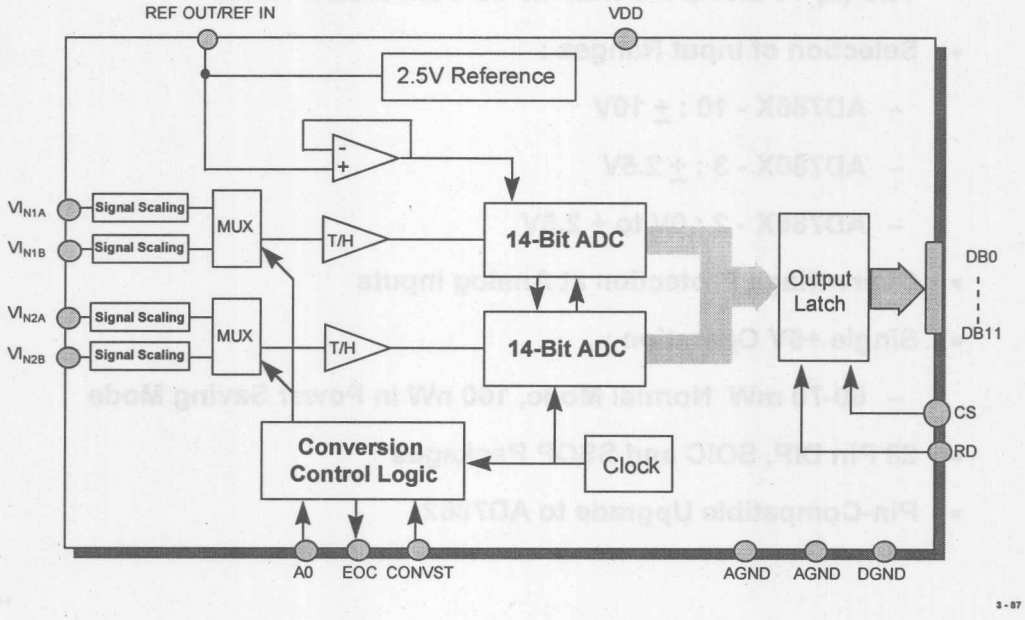
AD7863
Dual Channel, Simultaneous Sampling A/D Converters

The AD7863 14 Bit, 200 ksps A/D Converter provides simultaneous sampling and conversion of 2 phase-related or time-related signals. It also has a 2-channel multiplexer on each input, giving a total of 4 input channels.

The AD7863 is primarily designed for, but not limited to, motor control applications, such as AC servos and Inverters. The 2-channels of simultaneous sampling are used to control the two currents (3rd current is calculated) in a 3-phase system.

3 - 86

AD7863 - Simplified Diagram



AD7863 - Key Specs and Features

- Two (2) 14-bit ADC's with 4.5 us Conversion Times
- Selection of Input Ranges :
  - AD786X - 10 : ± 10V
  - AD786X - 3 : ± 2.5V
  - AD786X - 2 : 0V to + 2.5V
- Overvoltage Protection at Analog Inputs
- Single +5V Operation :
  - 60-70 mW Normal Mode, 100 nW in Power Saving Mode
- 28 Pin DIP, SOIC and SSOP Packages
- Pin-Compatible Upgrade to AD7862

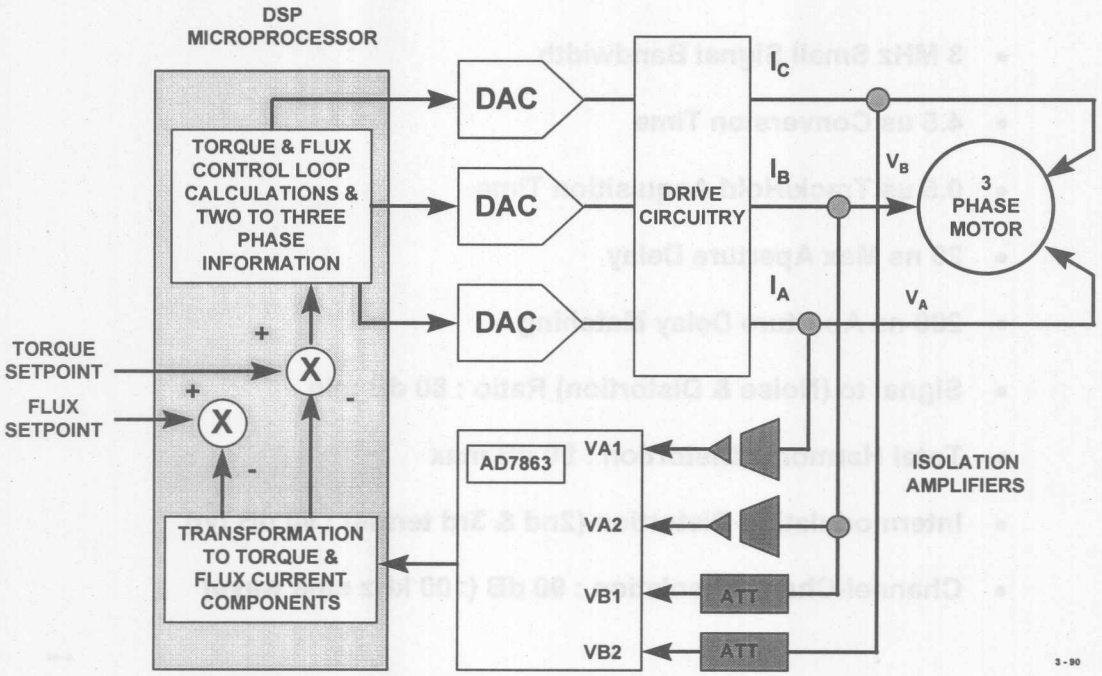
3 - 88

AD7863 Dynamic Performance

- 3 MHz Small Signal Bandwidth
- 4.5 us Conversion Time
- 0.5 us Track/Hold Acquisition Time
- 20 ns Max Aperture Delay
- 200 ns Aperture Delay Matching
- Signal to (Noise & Distortion) Ratio : 80 dB min
- Total Harmonic Distortion : 90 dB max
- Intermodulation Distortion (2nd & 3rd terms) : 90 dB typ
- Channel-Channel Isolation : 90 dB (100 kHz sine wave)

3 - 89

Vector Motor Control Using the AD7863

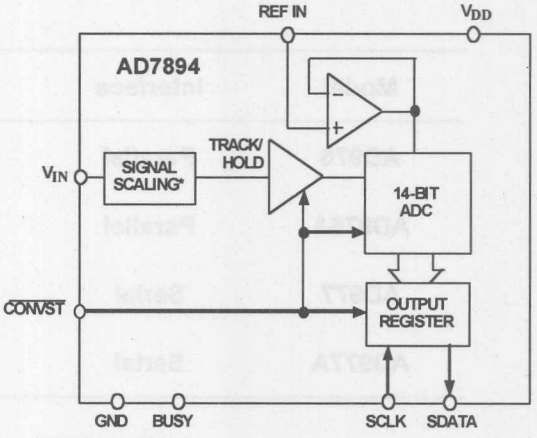


Preliminary Information

AD7894
5V, 14 Bit Serial Bipolar A/D Converter

The AD7894 provides bipolar operation and serial output in a compact 8 pin SOIC package!

- 4.5 us Conversion Time
- On-Chip Track/Hold
- Selection of Input Ranges:
  - AD7894 -10 : ± 10V
  - AD7894-3 : ± 2.5V
  - AD7894-2 : 0V to 2.5V
- High Speed Serial Interface
- Single Supply, Low Power Operation : 5V @ 20 mW



3 - 91

AD97X Family
16 Bit, Switched Capacitor A/D Converters

The AD97X Family employs a unique successive approximation, switched-capacitor architecture to achieve very high acuracy and low power.

Model	Interface	Speed	FP BW	SS BW
AD976	Parallel	100 ksps	700 kHz	1.5 MHz
AD976A	Parallel	200 ksps	1.0 MHz	2.7 MHz
AD977	Serial	100 ksps	700 kHz	1.5 MHz
AD977A	Serial	200 ksps	1.0 MHz	2.7 MHz

3 - 92

AD976X Family - Key Specs and Features

- Excellent AC Characteristics [1,2]
  - Spurious-Free Dynamic Range : 96 dB min
  - Total Harmonic Distortion : - 96 dB min
  - Signal to (Noise & Distortion) : 86 dB min
- Internal/External 2.5V Reference
- On-Chip Clock
- Package Styles :
  - AD976, AD976A : 28 Pin DIP, SOIC and SSOP
  - AD977, AD977A : 20 Pin DIP, SOIC; 28 Pin SSOP
- Single 5V Operation with only 100 mW of Power

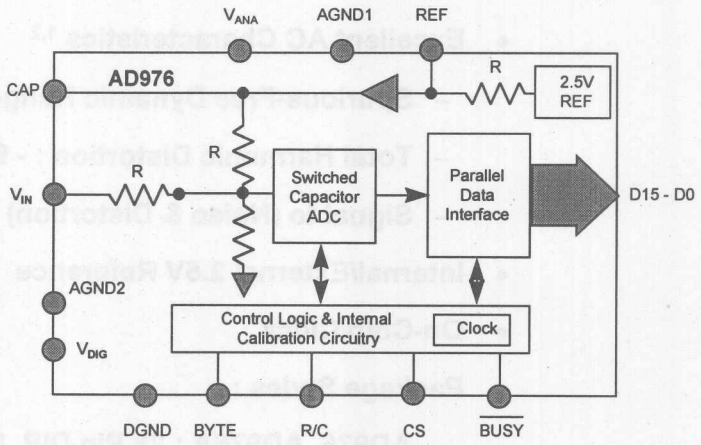
Notes:

1. "B" grade
2. 45 kHz, AD976/976A; 20 kHz, AD977/977A

3-93

AD976/AD976A - Simplified Diagram

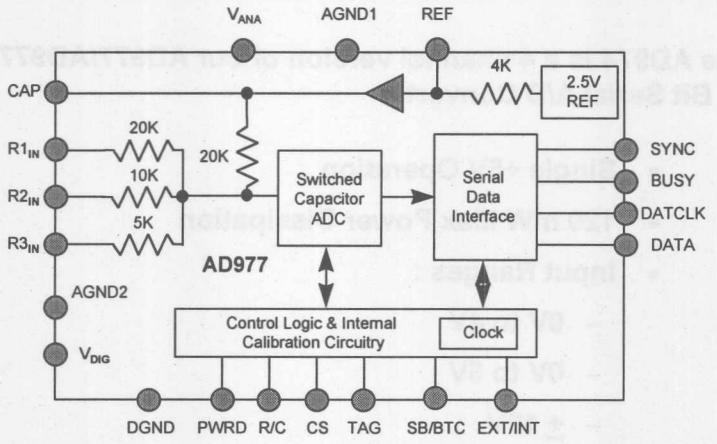
- **High Speed Parallel Interface**
- **Bipolar ± 10V Input Range**
- **BYTE Mode of Operation (see chart)**



PIN	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
BYTE LOW	MSB	D14	D13	D12	D11	D10	D9	D8	GND	D7	D6	D5	D4	D3	D2	D1	LSB
BYTE HIGH	D7	D6	D5	D4	D3	D2	D1	LSB	GND	MSB	D14	D13	D12	D11	D10	D9	D8

3-94

AD977/AD977A - Simplified Diagram



- **Multiple Input Ranges:**
  - **Unipolar : 0V to 4V, 0V to 5V, 0V to 10V**
  - **Bipolar : ± 3.3V, ± 5V, ± 10V**
- **Power Down Mode : 50 uW**
- **Internal/External Clock**

3 - 95

Preliminary Information

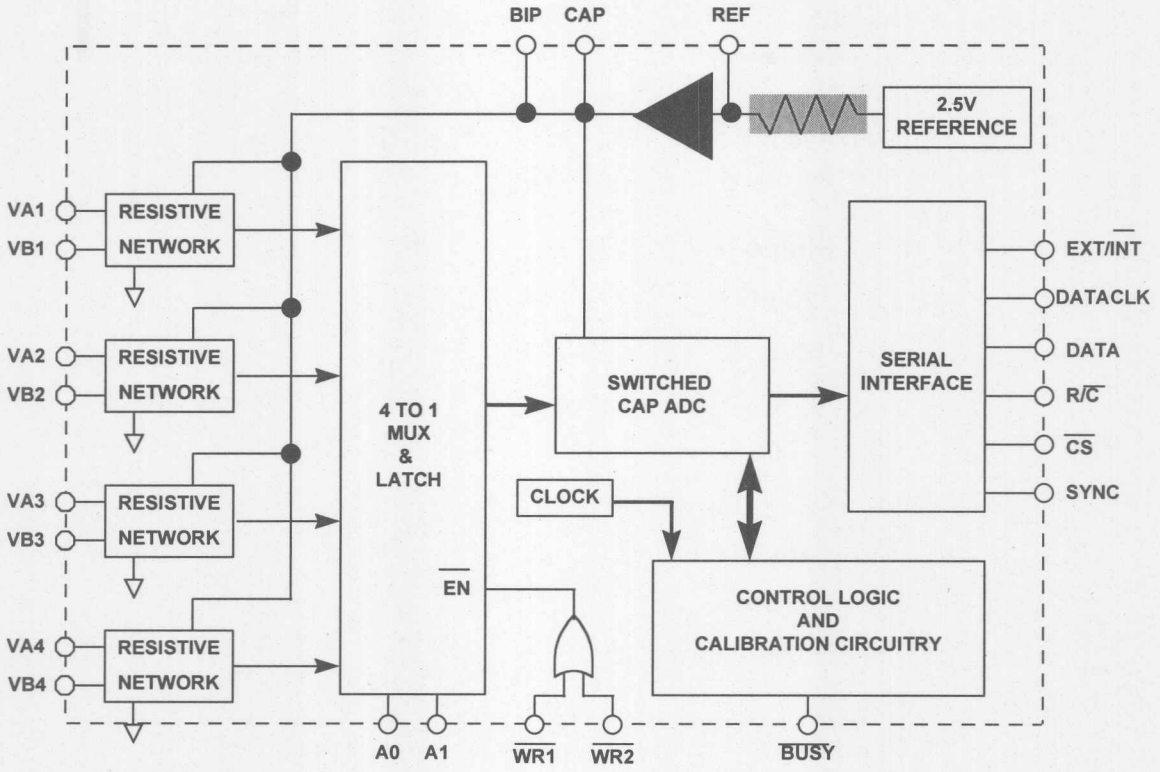
AD974*
16 Bit, 150 ksps, 4 Channel A/D Converter

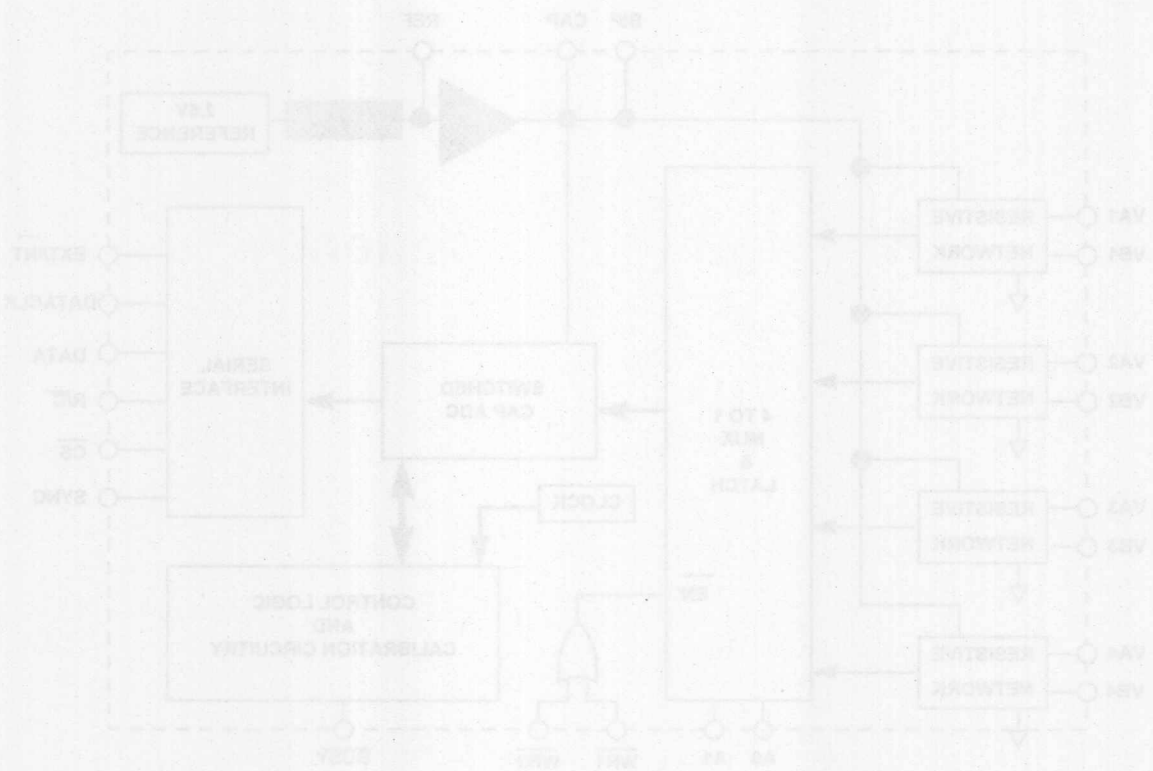
The AD974 is a 4 channel version of our AD977/AD977A 16 Bit Serial A/D Converter

- **Single +5V Operation**
- **120 mW Max Power Dissipation**
- **Input Ranges :**
  - **0V to 4V**
  - **0V to 5V**
  - **± 10V**
- **External or Internal 2.5V Reference**
- **On-Chip Clock**
- **Power Down Mode**

3 - 96

AD974 - Simplified Diagram



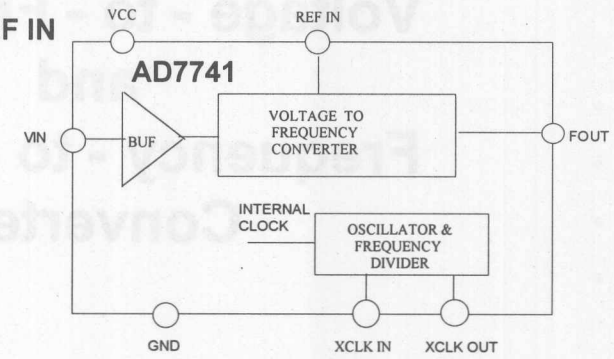


Voltage - to - Frequency and Frequency - to - Voltage Converters

Preliminary Information

AD7741
5 MHz Voltage - Frequency Converter

- Input Signal Range : 0V to REF IN
- 5 MHz Output Frequency
- External 2.5V Reference
- Internal Clock Oscillator
- Single 5V Operation
- 8-Pin DIP and SOIC Packages

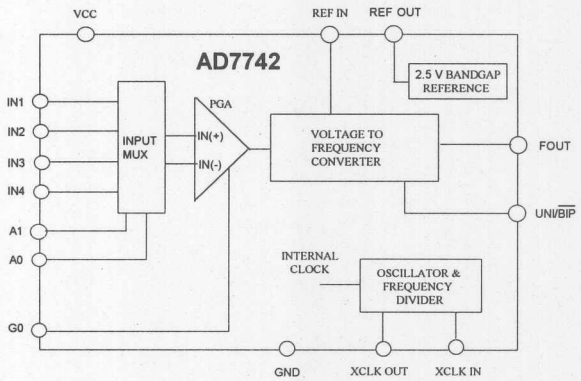


3 - 100

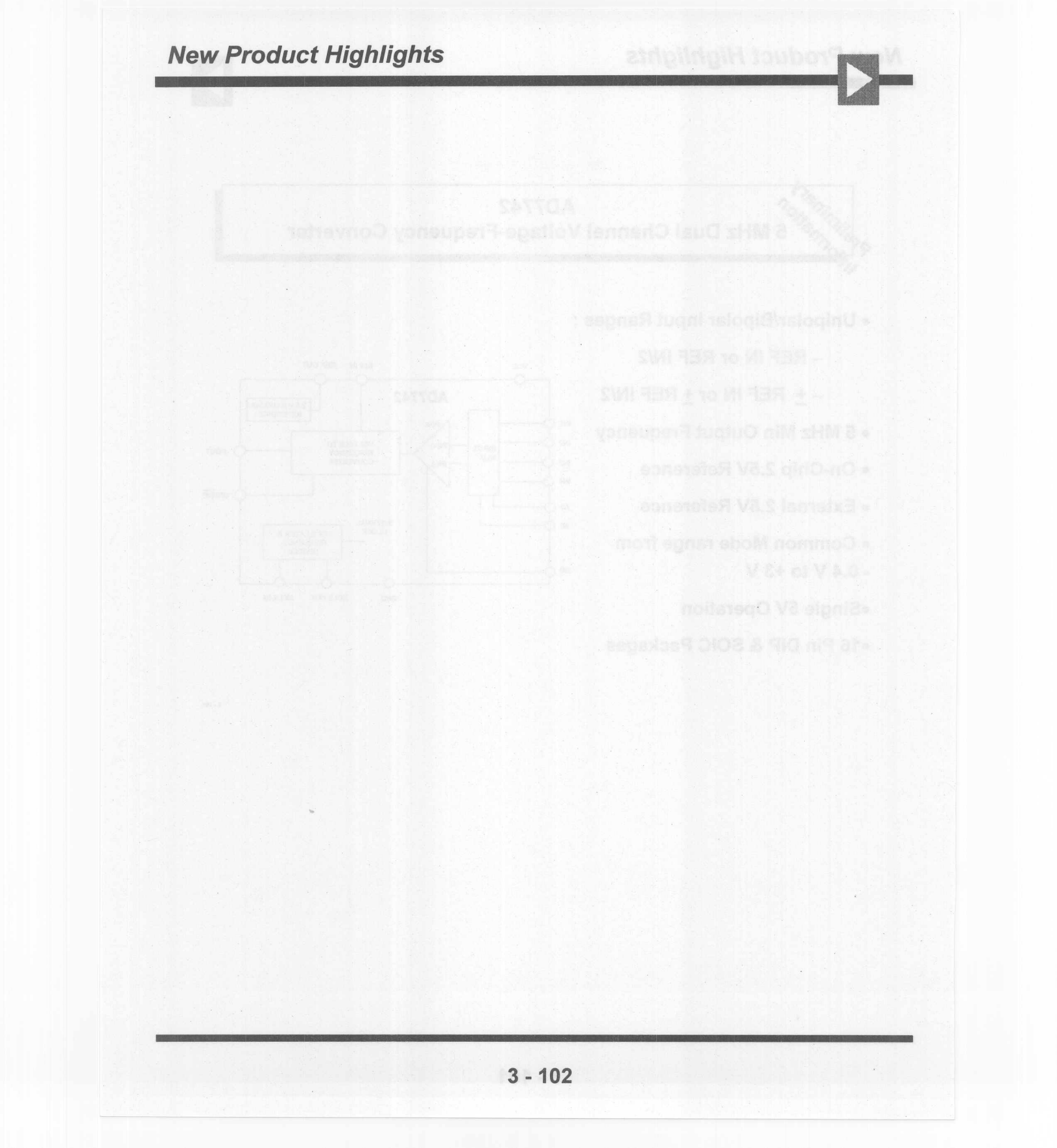
Preliminary Information

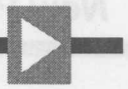
AD7742
5 MHz Dual Channel Voltage-Frequency Converter

- Unipolar/Bipolar Input Ranges :
  - REF IN or REF IN/2
  - ± REF IN or ± REF IN/2
- 5 MHz Min Output Frequency
- On-Chip 2.5V Reference
- External 2.5V Reference
- Common Mode range from - 0.4 V to +3 V
- Single 5V Operation
- 16 Pin DIP & SOIC Packages



3 - 101





Sigma-Delta (Σ–Δ) A/D Converters

What is a Sigma-Delta Converter?

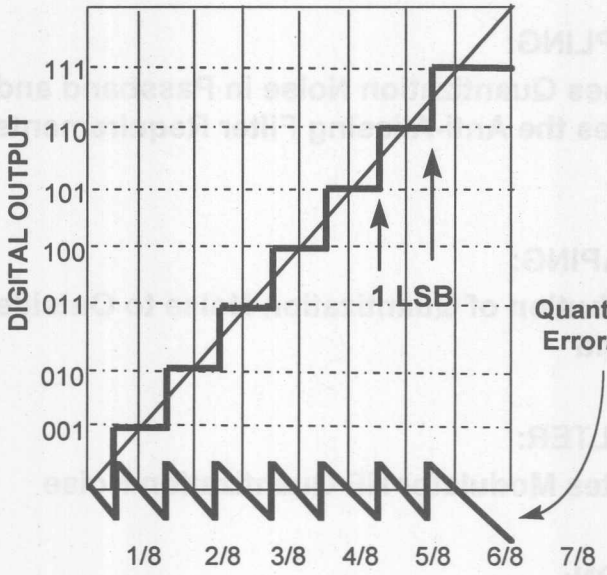
A Sigma-Delta Converter Uses Oversampling Plus Digital Filtering to Achieve Very High Resolution (18-24 Bits) at Only A Moderate Cost.

Basic Elements of the Sigma-Delta Converter...

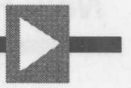
- **OVERSAMPLING:**
  - **Decreases Quantization Noise in Passband and Simplifies the Anti-Aliasing Filter Requirements at the Input**
- **NOISE SHAPING:**
  - **Redistribution of Quantization Noise to Outside Passband**
- **DIGITAL FILTER:**
  - **Eliminates Modulator HF Quantization Noise**
- **DECIMATION:**
  - **Reduces Output Data Rate**

3 - 105

A Review of Quantization Noise



3 - 106



Some Useful Equations from Quantization Theory

- Q is the size of the LSB
- The RMS value of the Quantization noise (sawtooth) is its peak value Q/2 divided by square root 3, or Q/ $\sqrt{12}$
- Full-scale Sinewave RMS Signal to RMS noise ratio in the Nyquist Bandwidth for an N-bit ADC,

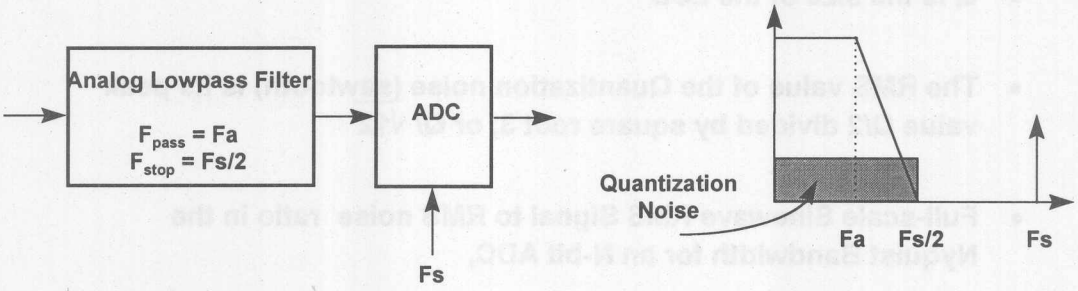
$$SNR = 6.02N + 1.76dB$$

- Effective Number of Bits (ENOB) equals, -

$$ENOB = \frac{SNR_{actual} - 1.76dB}{6.02N}$$

3 - 107

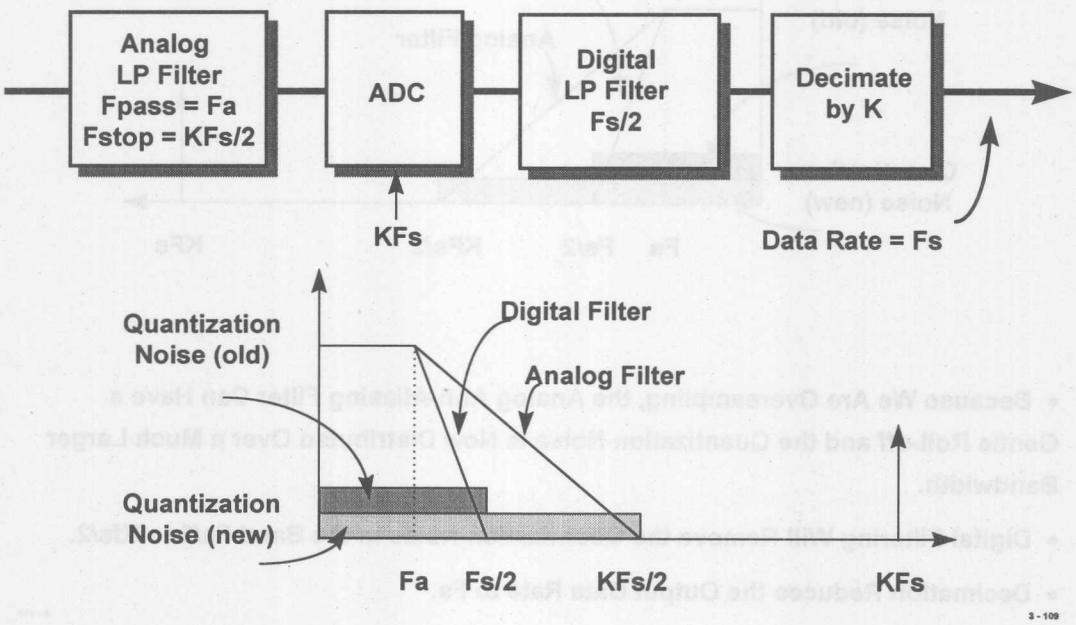
Sampling and the Nyquist Bandwidth...



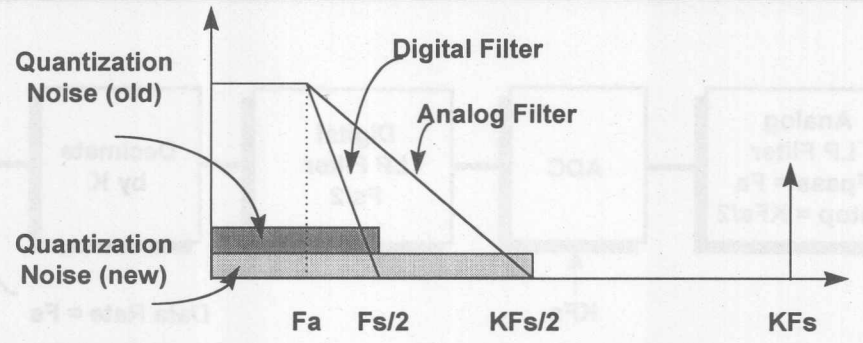
- The Nyquist Sampling Theory Demands That the Bandwidth of the Sampled Signal Be Less Than Half the Sampling Frequency to Prevent a Phenomenon Known As Aliasing.
- Using an "Anti-Aliasing" Filter, We Band-Limit the Input-Signal So That the Attenuation of the Signal Is Greater Than the Required Dynamic Range at Fs/2.
- The Quantization Noise Is Spread Evenly Over Fs/2.

3 - 108

Oversampling...



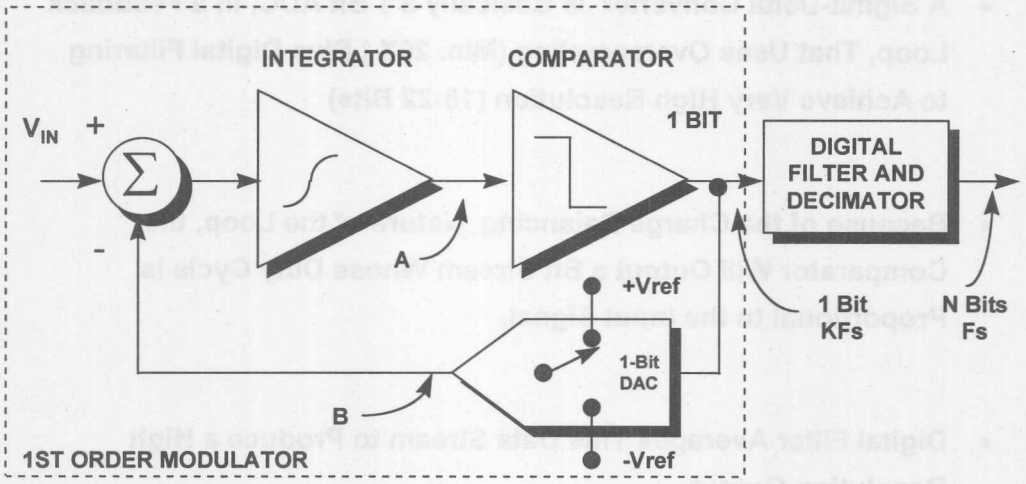
Oversampling (con't)



- Because We Are Oversampling, the Analog Anti-Aliasing Filter Can Have a Gentle Roll-off and the Quantization Noise Is Now Distributed Over a Much Larger Bandwidth.
- Digital Filtering Will Remove the Quantization Noise in the Band Fs/2 to Kfs/2.
- Decimation Reduces the Output Data Rate to Fs.

3 - 110

A Sigma-Delta A/D Converter



3 - 111

A Sigma-Delta A/D Converter (con't)

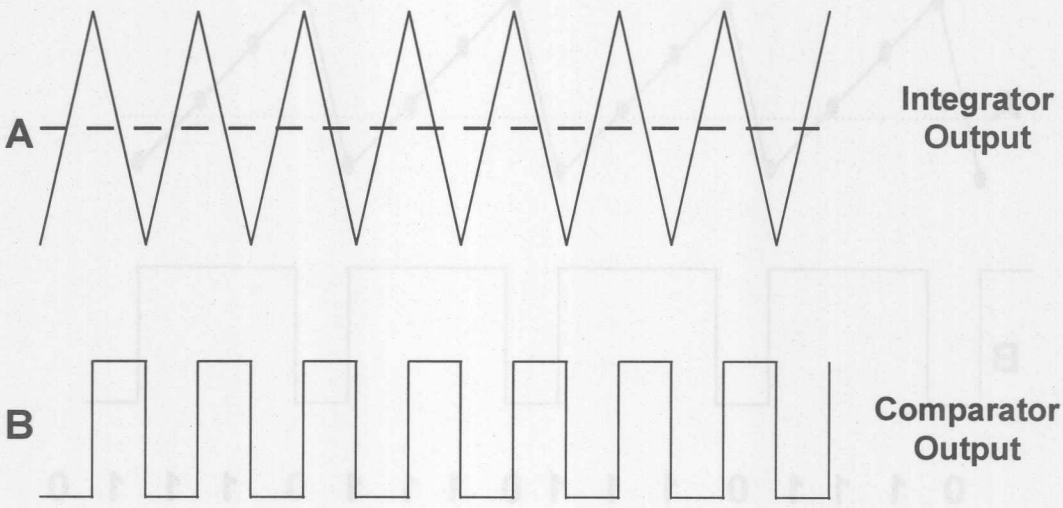
- A Sigma-Delta Converter Is Basically a 1 Bit ADC, in a Feedback Loop, That Uses Oversampling (Min. 20X) Plus Digital Filtering to Achieve Very High Resolution (18-22 Bits)

- Because of the Charge Balancing Nature of the Loop, the Comparator Will Output a Bit Stream Whose Duty Cycle Is Proportional to the Input Signal.

- Digital Filter Averages This Data Stream to Produce a High Resolution Output.

3 - 112

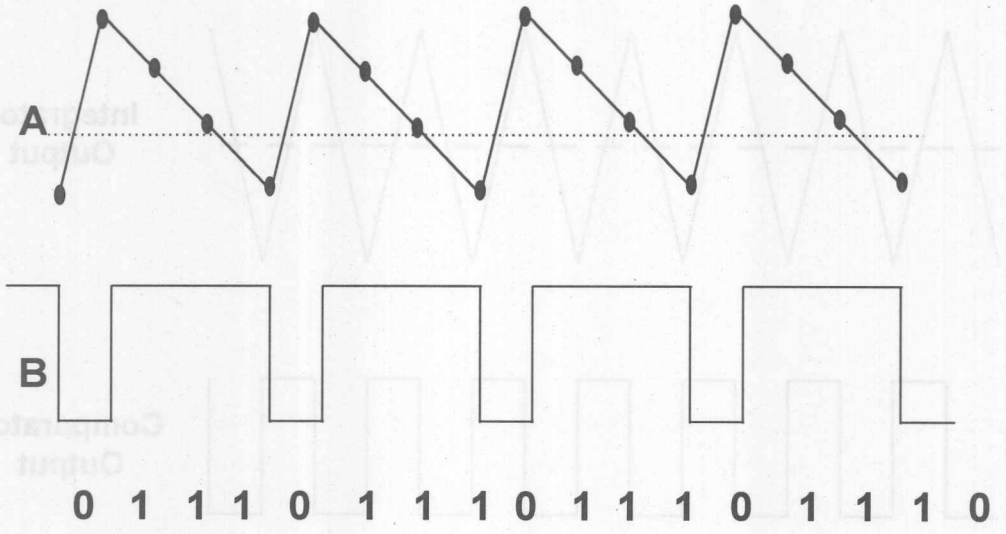
Sigma-Delta Modulator Waveforms...



Vin = 0V or Midscale

3 - 113

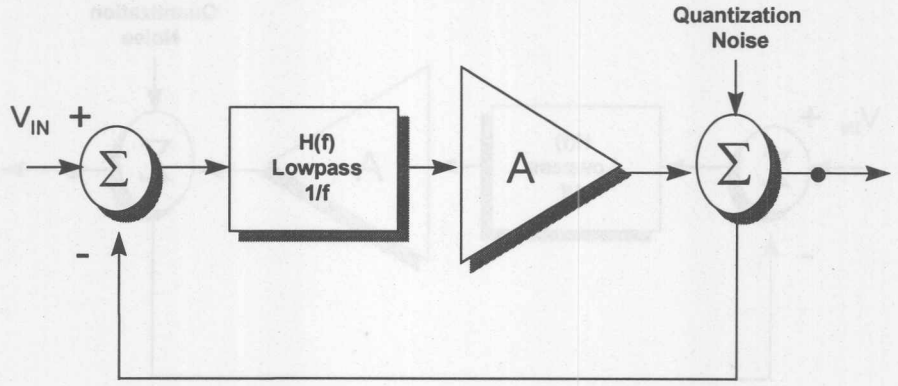
Sigma-Delta Modulator Waveforms (con't)



Vin = Vref/2 or 3/4 Span

3 - 114

Sigma Delta Converter (con't)



We approximate the integrator to a lowpass filter with a response of 1/f. We can approximate the comparator to a gain of 1 followed by a quantization noise injector. This yields, -

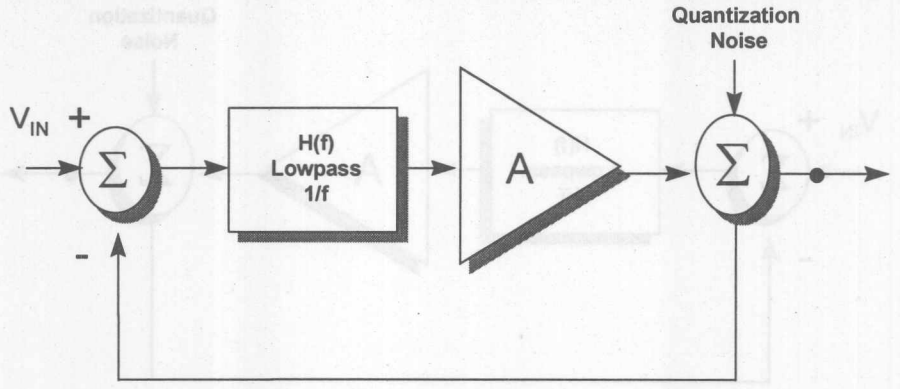
$$Y = (x-y)/f + q$$

or

$$Y = x/(f+1) + qf/(f+1)$$

3-115

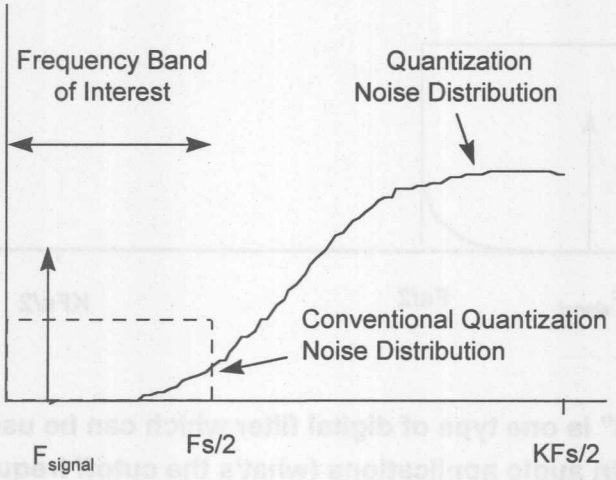
Sigma Delta Converter (con't)



As f approaches 0, y approaches x (i.e. The input signal), and as f increases, y becomes dominated by q (quantization noise). So the signal concentrates itself in the low frequency region while the quantization noise is located in a higher frequency region. We call this phenomenon noise shaping. This is very different from a conventional converter where the quantization noise is evenly spread throughout the 0 to fs/2 band.

3 - 116

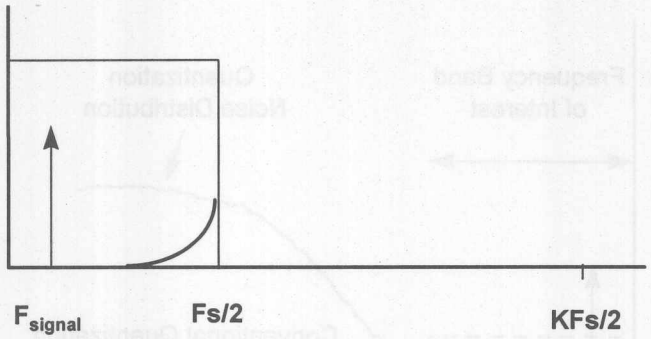
Here's What Noise Shaping Looks Like...



The effect of noise shaping has been to place the undesired quantization noise/error in a high frequency band where it can easily be removed using a digital filter.

3 - 117

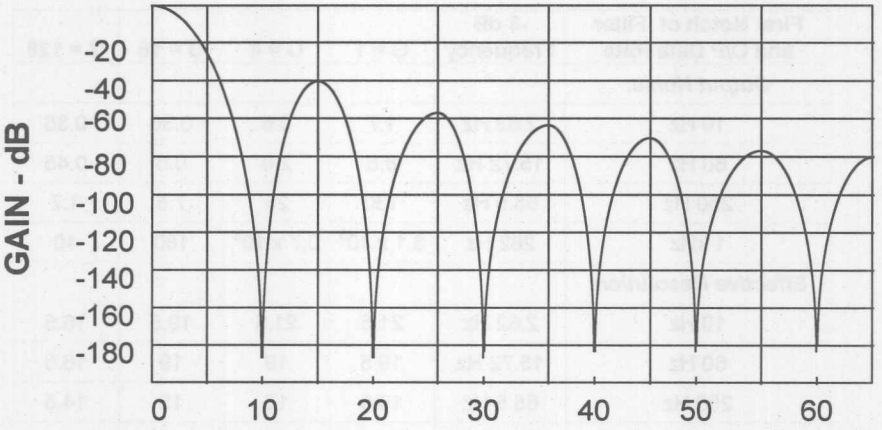
After Digital Filtering, We Get...



- A "Brickwall" is one type of digital filter which can be used. Brickwalls are popular in audio applications (what's the cutoff frequency?)
- Sometimes we use a different type of filter called a $(\sin x/x)^3$ or $sync^3$ or sync-cubed filter which we will look at later.
- It is also easy to integrate the decimation circuitry into the digital filter

3 - 118

Digital Filter Respnse



The Filter has notches at multiples of the programmed output data rate. The default first notch frequency (and hence data rate) is typically 60Hz.

Depending on the specific Model, the first notch frequency can be set any where between about 2Hz and 1000Hz. As we increase the notch frequency, we will tend to see an increase in noise and subsequent loss in resolution.

3 - 119

Typical Output RMS Noise in uV and Effective Resolution in Bits

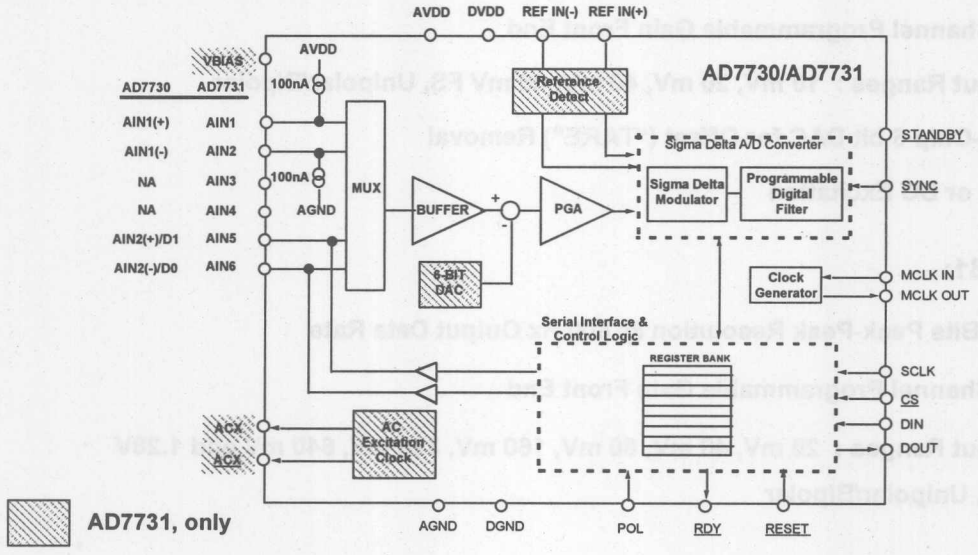
First Notch of Filter and O/P Data Rate	-3 dB Frequency	G = 1	G = 4	G = 16	G = 128
Output Noise:					
10 Hz	2.62 Hz	1.7	0.5	0.36	0.36
60 Hz	15.72 Hz	8.5	2.0	0.6	0.45
250 Hz	65.5 Hz	130	25	7.5	1.7
1 kHz	262 Hz	3.1×10^3	0.7×10^3	180	40
Effective Resolution:					
10 Hz	2.62 Hz	21.5	21.5	19.5	16.5
60 Hz	15.72 Hz	19.5	19	19	16.5
250 Hz	65.5 Hz	15.5	15	15	14.5
1 kHz	262 Hz	10.5	11	11	10

- **Device (Semiconductor, Resistor) Noise Dominates at the Lower Frequencies (< 60 Hz notch)**
- **Quantization Noise Dominates at the Higher Frequencies (Why?)**

3 - 120

AD7730 and AD7731
High Resolution Industrial A-D Converters

The AD7730 and AD7731 are functional complete solutions design-optimized for direct interface to weigh scales/pressure transducers (AD7730) or other process control transducers (AD7731).



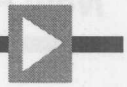
AD7730, AD7731 - Key Model Differences

AD7730:

- **Resolution of 1 in 230,000 Counts (Peak-Peak)**
- **2 Channel Programmable Gain Front End**
- **Input Ranges : 10 mV, 20 mV, 40 mV, 80 mV FS, Unipolar/Bipolar**
- **On-Chip 6 bit DAC for Offset ("TARE") Removal**
- **AC or DC Excitation**

AD7731:

- **16 Bits Peak-Peak Resolution @ 800 Hz Output Data Rate**
- **6 Channel Programmable Gain Front End**
- **Input Ranges : 20 mV, 40 mV, 80 mV, 160 mV, 320 mV, 640 mV and 1.28V FS, Unipolar/Bipolar**



AD7730, AD7731 - Common Key Specs and Features:

- **No Missing Codes to 24 Bits**
- **Programmable Filter Cutoff/Output Data Rates from 50 Hz to 7.6 kHz (12 bits) @ F_{CLOCK} = 4.9152 MHz Clock Frequency**
- **DC Stability (CHP = 1) :**
  - **Offset Drift vs Temp : 5 nV/deg C**
  - **Offset Drift vs Time : 25 nV/1000 hrs**
  - **Gain Drift : 2 ppm/deg C max**
  - **Gain Drift vs Time : 25 ppm/1000 hrs**
- **"CHOP" Mode reduces Drift, Improves Noise Immunity**

3 - 123

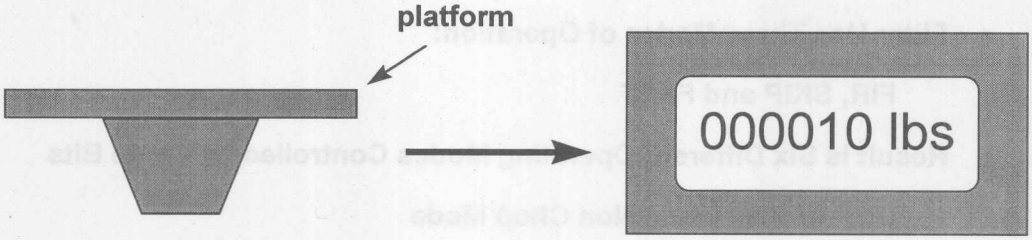
AD7730, AD7731 - Common Key Specs and Features (con't):

- 100 nA Transducer "Burnout" Current
- 50/60 Hz Common Mode Rejection : 120 dB, min
- 50 Hz/60 Hz Normal Mode Rejection : 88 dB, min
- Power Supply Rejection Ratio : 90 dB, min
- Self and System Calibration
- "*FAST*Step™" Mode for Channel Sequencing
- Single +5V Operation
  - 50 mW Normal Mode, 100 uW SHUTDOWN Mode
- 24 Pin DIP, SOIC and TSSOP Packages

3 - 124

"Tare" Weight Compensation - What is it?

The TARE Weight is the weight of the scale's platform or receptacle... its weight introduces an offset that can be as much as 20%of the scale's FS range and must be nulled out before an actual weight measurement can be made.



Platform Scale **Digital Readout**

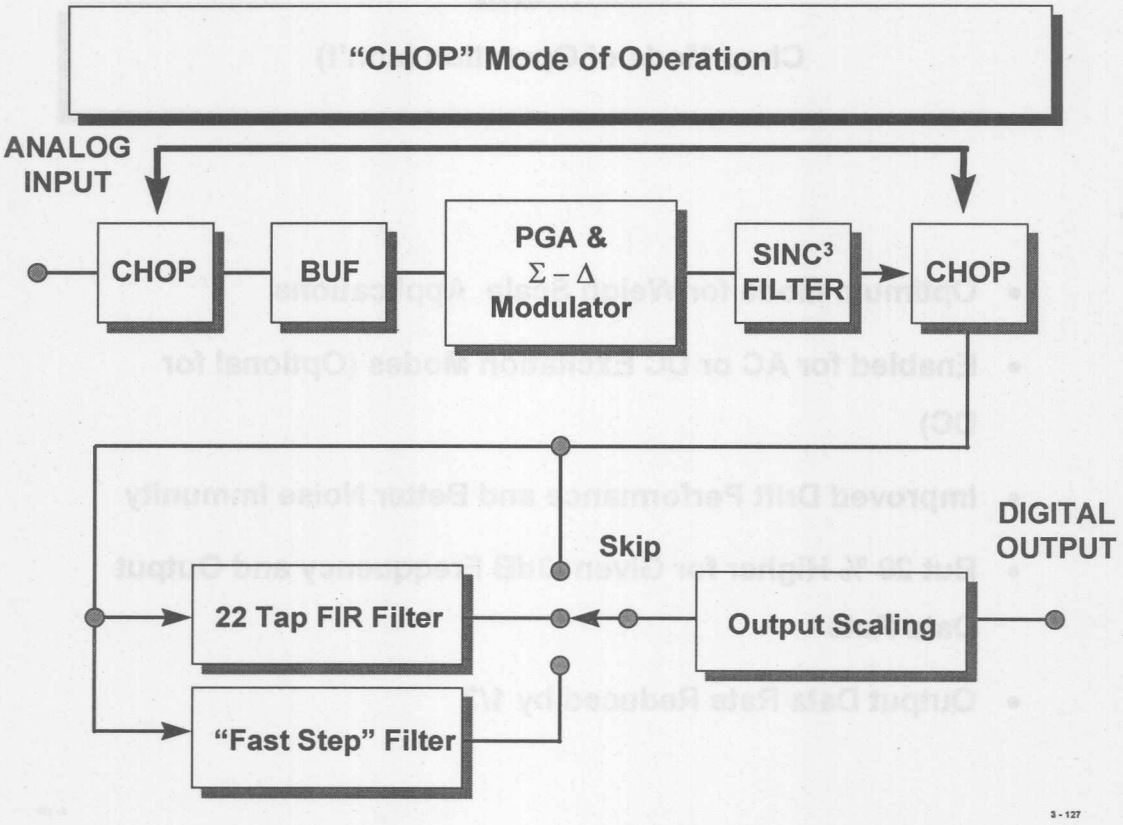
3 - 125

Modes of Operation

- AD7730, AD7731 have Two Primary Modes of Operation:
  - Chop and Non-Chop Mode
- Filter Has Three Modes of Operation:

  FIR, SKIP and FAST
- Result is Six Different Operating Modes Controlled by Three Bits
  - CHP for Chop and Non Chop Mode
  - SKIP for Bypassing Second Stage Filter
  - FAST for Enabling FASTSTEP Mode

3 - 126


"CHOP" Mode of Operation
ANALOG INPUT
CHOP
BUF
PGA & Σ – Δ Modulator
SINC³ FILTER
CHOP
Skip
DIGITAL OUTPUT
22 Tap FIR Filter
Output Scaling
"Fast Step" Filter
3 - 127

Chop Mode of Operation (con't)

- **Optimum Mode for Weigh Scale Applications**
- **Enabled for AC or DC Excitation Modes (Optional for DC)**
- **Improved Drift Performance and Better Noise Immunity**
- **But 20 % Higher for Given -3dB Freqquency and Output Data Rate**
- **Output Data Rate Reduced by 1/3**

3 - 128

Chop vs Non-Chop Mode of Operation

- Part is Chopped at Front End and After First-Stage Filter
- Signal Chain is Chopped as Well as Individual Elements
- Chop Mode Results in -
  - Excellent Drift Performance
  - Better Noise Immunity
  - Better Power Supply Rejection
  - Better EMI Rejection
- Non-Chop Mode Allows a Range of -
  - Faster Settling-Time
  - Faster Throughput Rates

3 - 129

Summary of Operating Modes

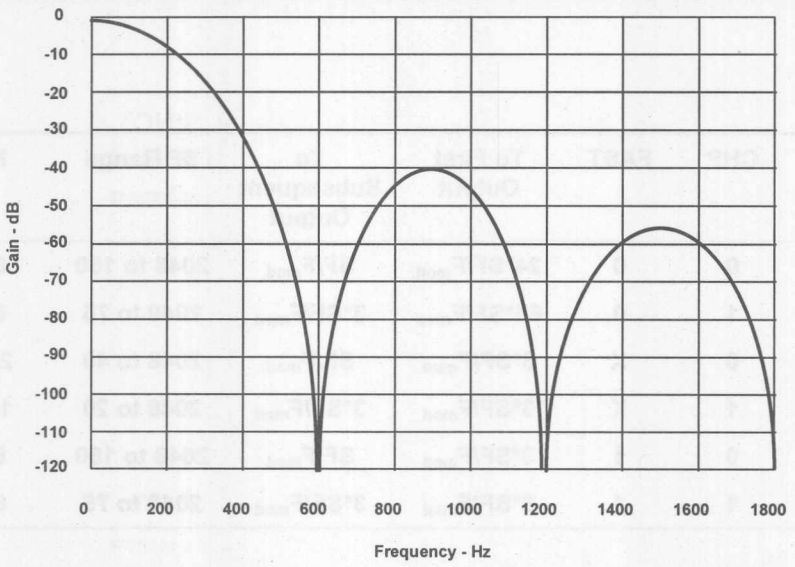
SKIP	CHP	FAST	COMMENTS
0	0	0	Medium Output Rates. Slow Settling. Very Good Noise, but Reduced PSRR and Poorer Drift
0	1	0	Medium Output Rates. Slowest Settling. Best Noise, PSRR, Drift
1	0	X	Fastest Output Rates & Settling Time. Poorer Noise, PSRR & Drift
1	1	X	Fast Output Rates & Settling Time. Good PSRR & Drift. Data Has to be Processed in Pairs
0	0	1	Medium Output Rates. Fast Settling. Good Noise, but Poorer PSRR and Drift
0	1	1	Medium Output Rates. Fast Settling. Best Noise, PSRR and Drift

3 - 130

Settling Time and Output Rate

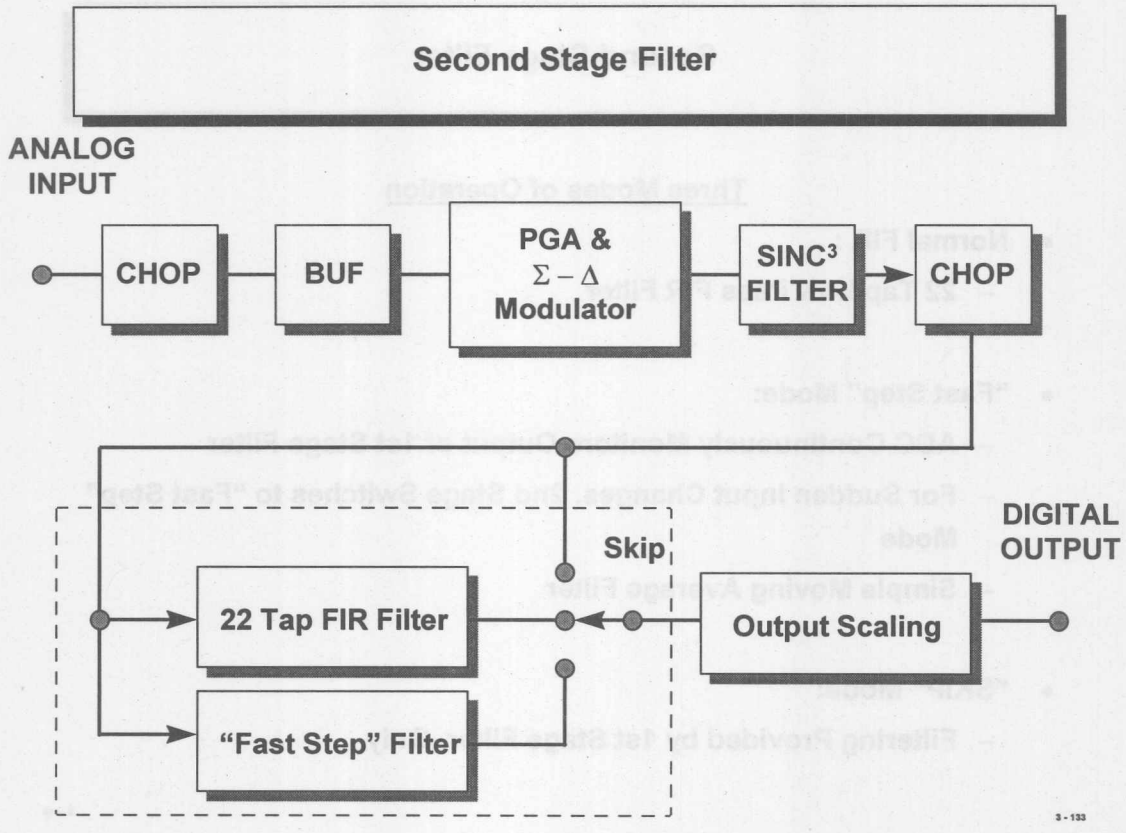
SKIP	CHP	FAST	To First Output	To Subsequent Output	SF Range	Noise
0	0	0	$24*SF/F_{mod}$	SF/F_{mod}	2048 to 150	80 nV
0	1	0	$66*SF/F_{mod}$	$3*SF/F_{mod}$	2048 to 75	60 nV
1	0	X	$3*SF/F_{mod}$	SF/F_{mod}	2048 to 40	200 nV
1	1	X	$3*SF/F_{mod}$	$3*SF/F_{mod}$	2048 to 20	140 nV
0	0	1	$3*SF/F_{mod}$	SF/F_{mod}	2048 to 150	80 nV
0	1	1	$6*SF/F_{mod}$	$3*SF/F_{mod}$	2048 to 75	60 nV

First Stage Filter



The first stage filter is a low pass, $sinc^3$ or $(sinx/x)^3$ filter whose primary function is to remove the quantization noise introduced at the modulator. The cutoff frequency and output data rate of this filter is programmed via a 12 bit word in the Filter Register

3 - 132


Second Stage Filter
ANALOG INPUT
CHOP
BUF
PGA & Σ – Δ Modulator
SINC³ FILTER
CHOP
DIGITAL OUTPUT
Skip
22 Tap FIR Filter
Output Scaling
"Fast Step" Filter
3 - 133

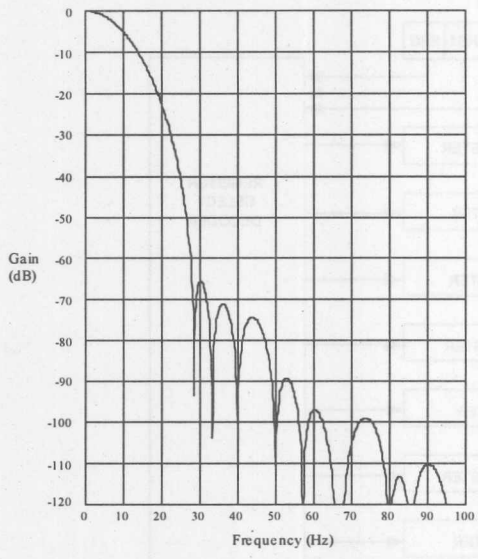
Second Stage Filter

Three Modes of Operation

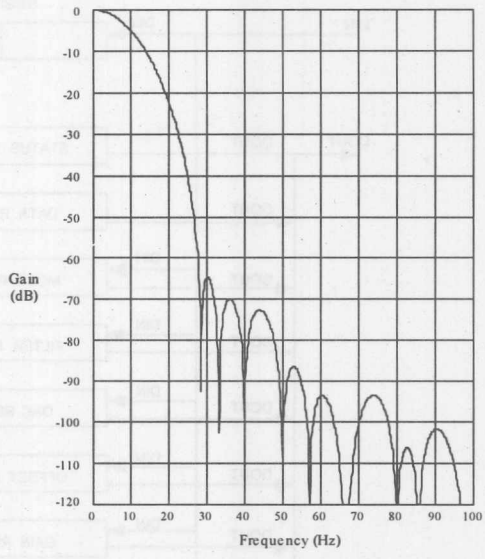
- **Normal FIR :**
  - **22 Tap Low Pass FIR Filter**
- **"Fast Step" Mode:**
  - **ADC Continuously Monitors Output of 1st Stage Filter**
  - **For Sudden Input Changes, 2nd Stage Switches to "Fast Step" Mode**
  - **Simple Moving Average Filter**
- **"SKIP" Mode:**
  - **Filtering Provided by 1st Stage Filter, Only**

3 - 134

Second Stage Filter - Frequency Response



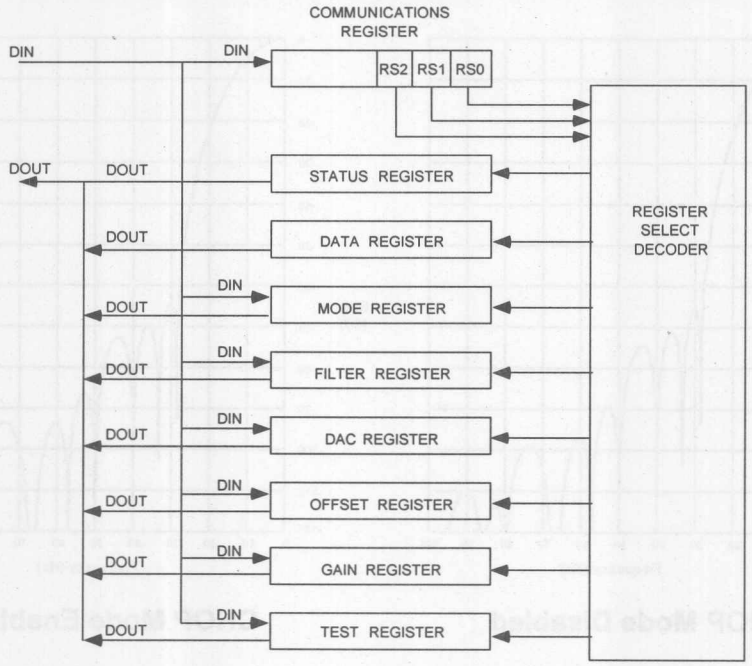
CHOP Mode Disabled



CHOP Mode Enabled

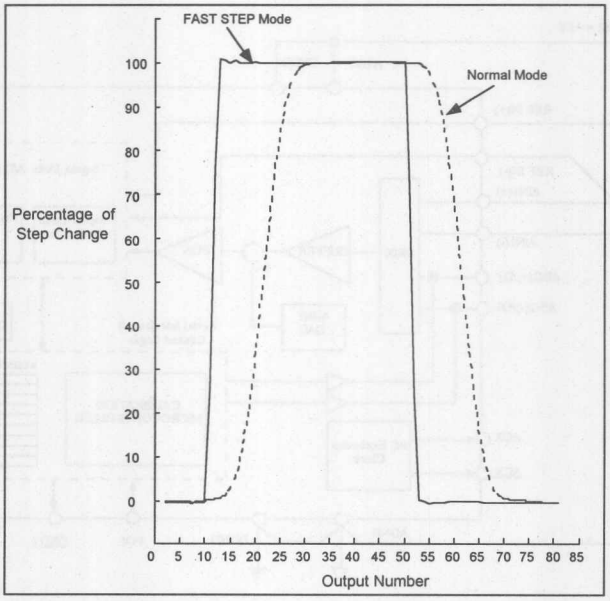
3 - 135

AD7730 Register Overview



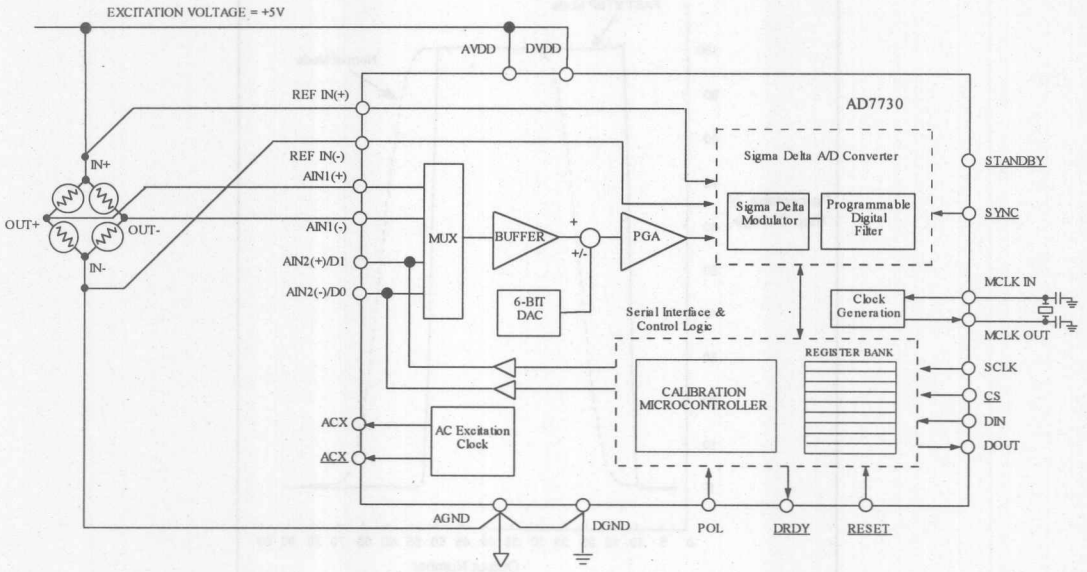
3 - 136

"Fast Step" Response



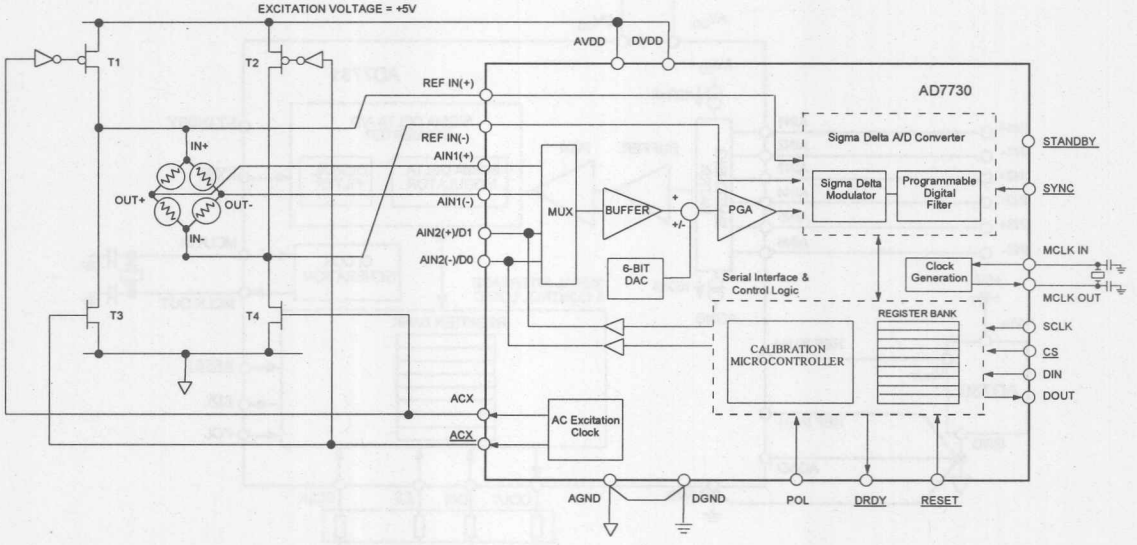
3 - 137

AD7730 - Typical Connections for DC-Excited Bridge



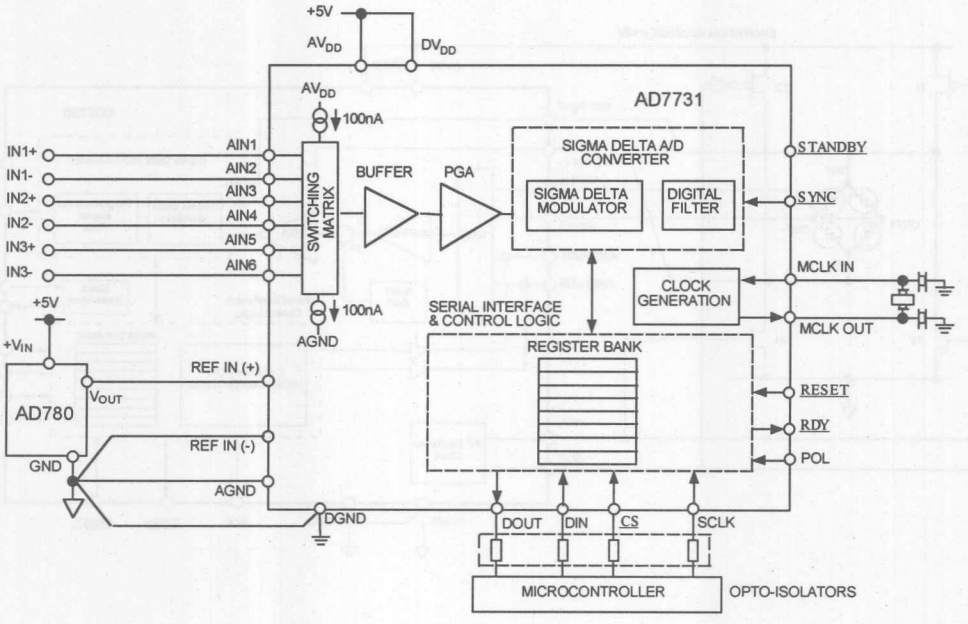
3 - 138

AD7730 - Typical Connections for AC-Excited Bridge

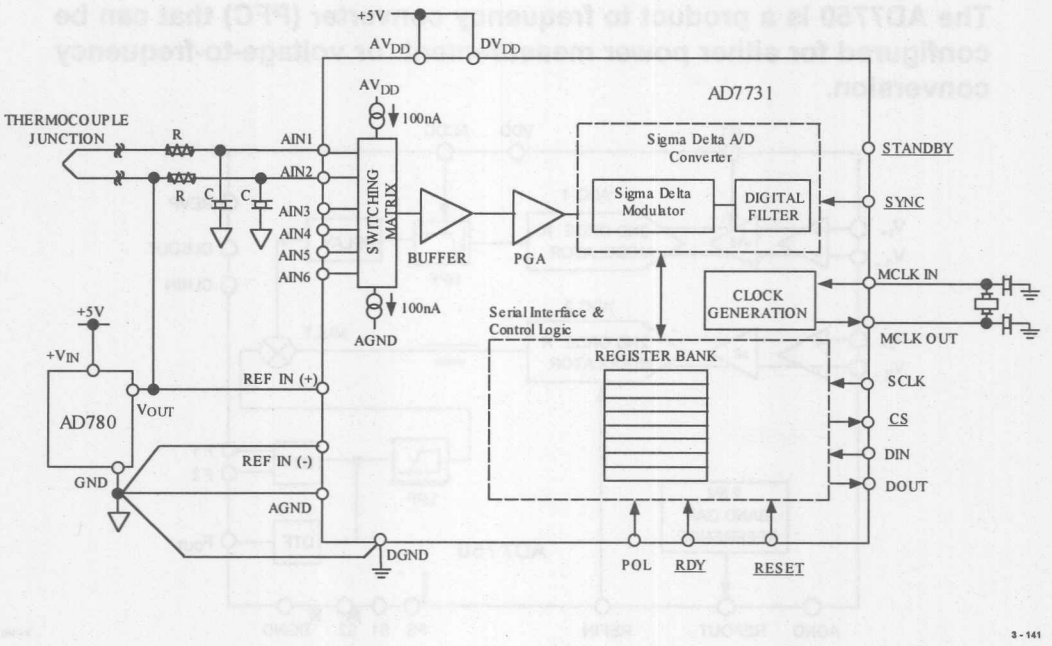


3 - 139

AD7731 - Data Acquisition System

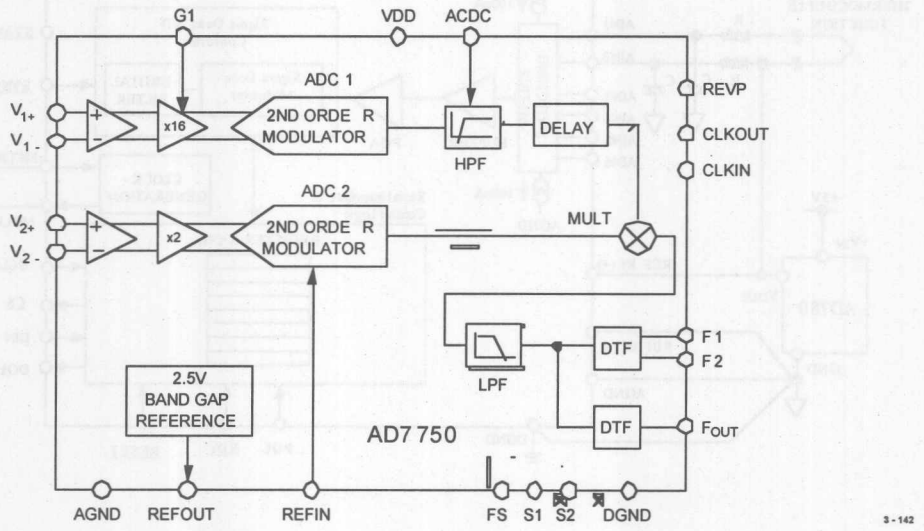


AD7731 - Thermocouple Application



AD7750
Product to Frequency Converter

The AD7750 is a product to frequency converter (PFC) that can be configured for either power measurement or voltage-to-frequency conversion.



AD7750 - Key Specs and Features

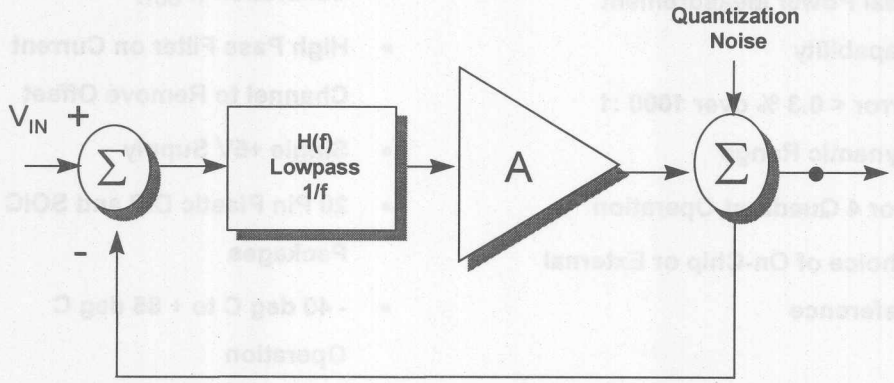
- Power Measurement (Product of 2 Channels)
- Voltage to Frequency Conversion
- Real Power Measurement Capability
- Error < 0.3 % over 1000 :1 Dynamic Range
- 2 or 4 Quadrant Operation
- Choice of On-Chip or External Reference
- Choice of Output Pulse Frequencies (F1 and F2)
- High Frequency Pulse Output for Calibration (F_{OUT})
- High Pass Filter on Current Channel to Remove Offset
- Single +5V Supply
- 20 Pin Plastic DIP and SOIC Packages
- - 40 deg C to + 85 deg C Operation

3 - 143

Preliminary Information

AD7723
1.2 MHz Sigma-Delta A/D Converter

The AD7723 provides true 16 bit performance for input bandwidths up to 460 kHz, at an output word rate up to 1.2 MHz. The sample rate, filter corner frequencies and output word rate are set by the crystal oscillator or external clock frequency



3 - 144

AD7723 - Key Specs and Features

- **Flexible 16 Bit Serial and Parallel Interface**
- **1 MHz to 19.2 MHz Master Clock Frequency**
- **32/16 X Oversampling Ratio**
- **Output Data Rate :**
  - **31.25 kHz - 600 kHz, $F_{CLKIN}/32$**
  - **62.50 kHz - 1.2 MHz, $F_{CLKIN}/16$**
- **Signal Input Range:**
  - **Unipolar : 0 to V_{ref}**
  - **Bipolar : $\pm V_{ref}/2$**

3 - 145

AD7723 - Key Specs and Features (con't)

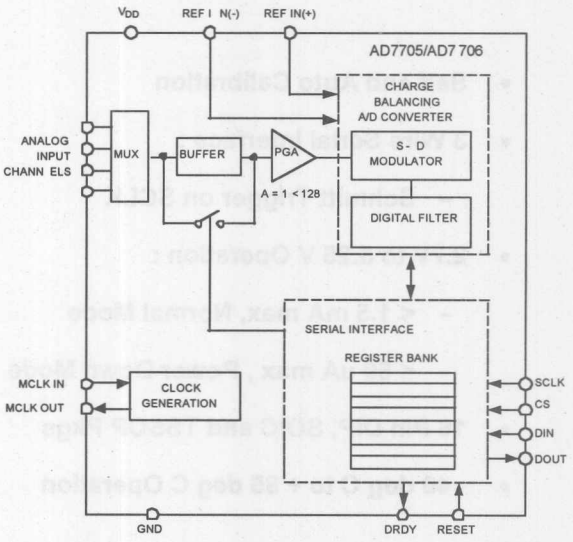
- Dynamic Performance (Decimate by 32) :
  - Signal to(Noise & Distortion) 87 dB, min
  - Total Harmonic Distortion : - 90 dB, max
- Low Pass and Band Pass Digital Filter :
  - Linear Phase
  - ± 0.001 dB Max Flatness, DC - 230 kHz
- Internal 2.5 V Reference
- + 5V Single Supply Operation
  - 300 mW max, normal mode
  - 50 uW max, STANDBY mode

3 - 146

Preliminary Information

AD7705, AD7706
16 Bit Sigma Delta A/D Converters

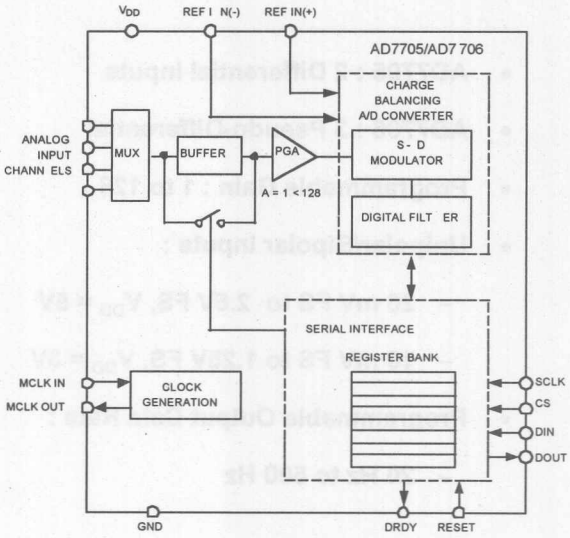
- AD7705 : 2 Differential Inputs
- AD7706 : 3 Pseudo-Differential
- Programmable Gain : 1 to 128
- Unipolar/Bipolar Inputs :
  - 20 mV FS to 2.5V FS, V_{DD} = 5V
  - 10 mV FS to 1.25V FS, V_{DD} = 3V
- Programmable Output Data Rate :
  - 20 Hz to 500 Hz



3 - 147

AD7705, AD7706 - Key Specs and Features (con't)

- Self and Auto Calibration
- 3 Wire Serial Interface :
  - Schmitt Trigger on SCLK
- 2.7V to 5.25 V Operation :
  - < 1.5 mA max, Normal Mode
  - < 50 uA max , Power Down Mode
- 16 Pin DIP, SOIC and TSSOP Pkgs
- - 40 deg C to + 85 deg C Operation



3 - 148

Preliminary Information

AD7729
15 Bit, Sigma Delta A/D Converter

The AD7729 is a dual channel, simultaneous sampling sigma delta A/D converter design-optimized for digitizing I and Q baseband signals

A/D Converter Inputs :

- **Baseband and Auxiliary Serial Ports (BSPORT/ASPORT)**
- **Differential I and Q Baseband Receive Inputs :**
  - **66 dB Typical Dynamic Range**
  - **Signal to (Noise & Distortion) : 60 dB, min**
- **270 kHz Output Word Rate**
- **2's Complement Coding (A/D)**
- **On-Chip Offset Calibration**

3 - 149

AD7729 - Key Specs and Features (con't)

Auxiliary DAC Channel :

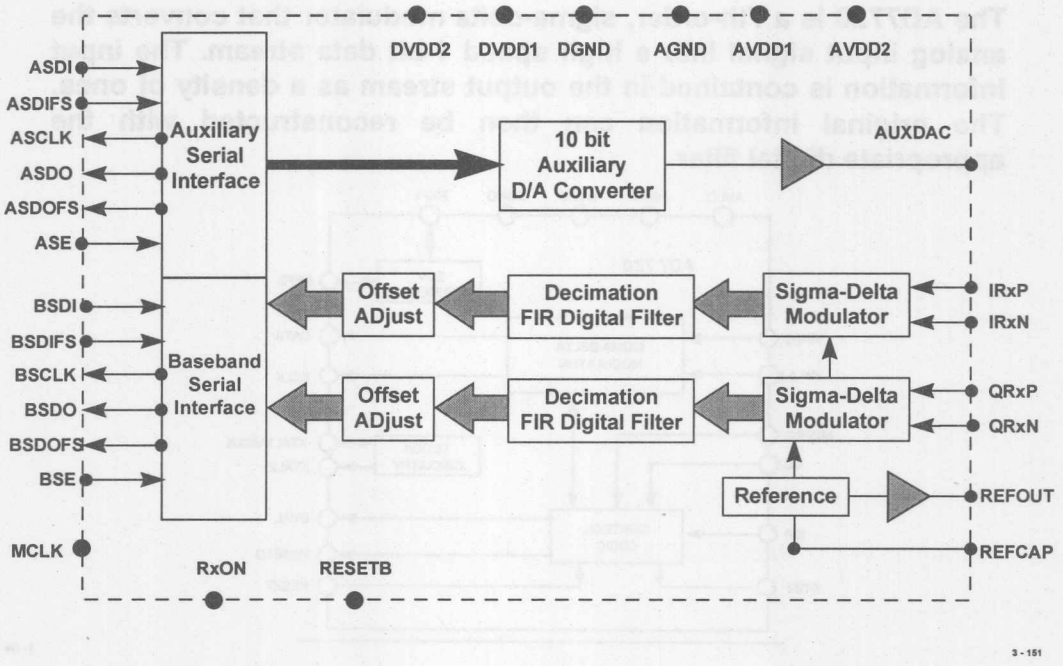
- 10 Bit Resolution, Binary Coding
- 540 kHz Update Rate
- 8 us Settling Time
- Can Be Used for AGC Function

General Specifications :

- 2.7V to 5.5 V Power Supply Range
- Low Power :
  - 32 mA typ, Full Operation, 250 uA typ, SHUTDOWN Mode
- 28 Pin SOIC and TSSOP Packages
- - 40 deg C to + 85 deg C Operation

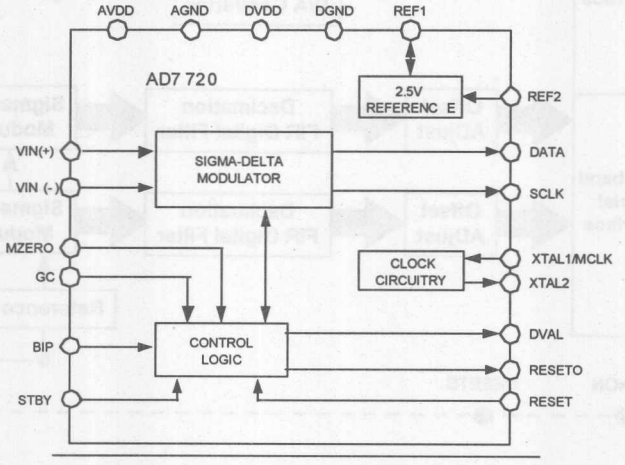
3 - 150

AD7729 - Simplified Diagram



AD7720
Sigma-Delta Modulator

The AD7720 is a 7th-order, sigma-delta modulator that converts the analog input signal into a high speed 1-bit data stream. The input information is contained in the output stream as a density of ones. The original information can then be reconstructed with the appropriate digital filter.



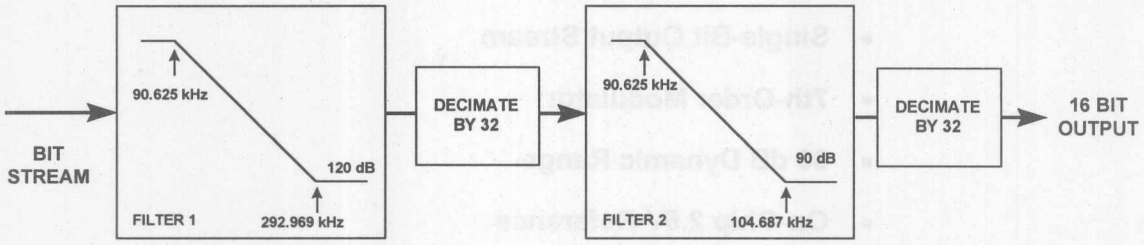
3 - 152

AD7720 - Key Specs and Features

- Sample Rate; 12.5 MHz Max
- 0V to +2.5V or ± 2.5V Input Range
- Single-Bit Output Stream
- 7th-Order Modulator
- 90 dB Dynamic Range
- On-Chip 2.5V Reference
- 120 kHz Bandwidth, typ
- Single, 5 V Power Supply Operation
- 28 Pin TSSOP Package
- -40 deg C to +85 deg C Operation

3 - 153

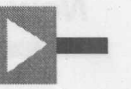
Digital Filter (Used in the AD7722)



Bandwidth = 90.625 kHz
Transition = 292.969 kHz
Attenuation = 120 dB
Coefficients = 384

Bandwidth = 90.625 kHz
Transition = 104.687 kHz
Attenuation = 90 dB
Coefficients = 151

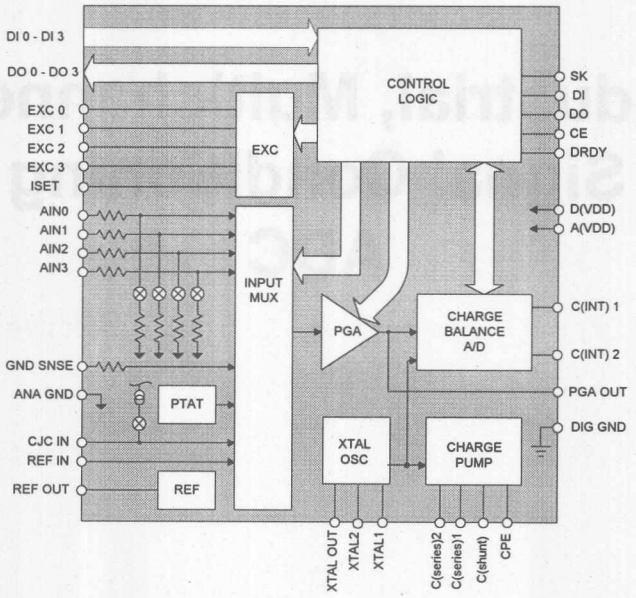
3 - 154



Industrial, Multichannel, Signal Conditioning ADC

AD280
4 Channel, Industrial Signal Conditioning + 16 bit ADC

The AD280 is a complete low cost front end solution to industrial data acquisition applications



AD280 - Key Specs and Features

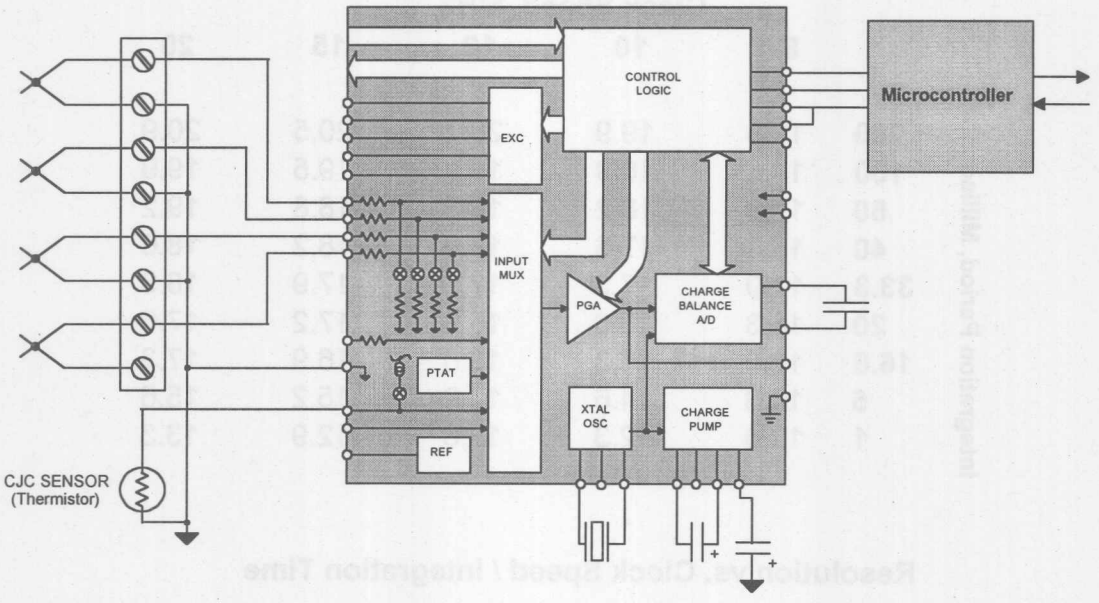
- **16 Bit Integrating A/D Converter with Programmable Integration Periods from 1.0 ms to 200 ms**
- **Selectable Full Scale Input Ranges : ± 2.5V and ± 10V**
- **± 30 V Overvoltage Input Protection**
- **On Board PGA Provides Binary Gains from 1 to 128**
- **Software-Configurable for Thermocouple, RTD, Millivolt and Voltage Inputs**
- **Programmable Excitation Sources for RTDs and Open Input Detection**

AD280 - Key Specs and Features (con't)

- On Board 2.5V Reference
- On-Board Crystal Oscillator
- Single +5 V Supply With Disable.
- "SPI" Compatible 2sc Serial Interface
- Auxiliary Digital I/O : 4 Input & 4 Outputs.
- 44 Pin Plastic Quad Flatpack
- - 25 deg C to + 85 deg C

3 - 158

Thermocouple Application



3 - 159

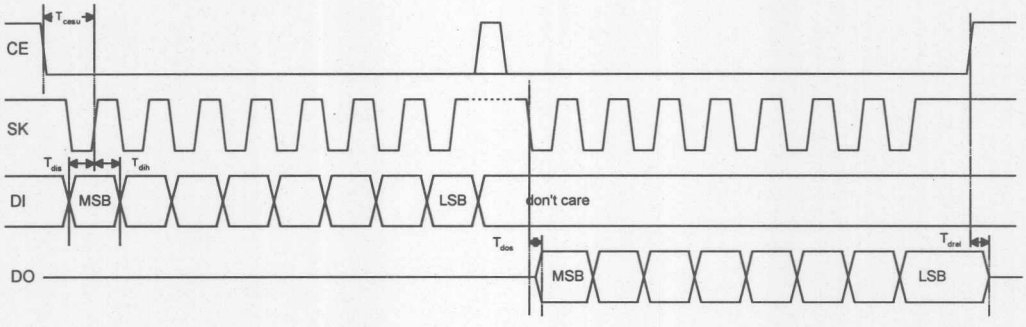
AD280 Integration Period vs Resolution

Integration Period, Milliseconds	Clock Speed, MHz 8	10	12	15	20
200	19.6	19.9	20.2	20.5	20.9
100	18.6	18.9	19.2	19.5	19.9
60	17.9	18.2	18.5	18.8	19.2
40	17.3	17.6	17.9	18.2	18.6
33.3	17.0	17.3	17.6	17.9	18.3
20	16.3	16.6	16.9	17.2	17.6
16.6	16.0	16.3	16.6	16.9	17.3
5	14.3	14.6	14.9	15.2	15.6
1	12.0	12.3	12.6	12.9	13.3

Resolution vs. Clock Speed / Integration Time

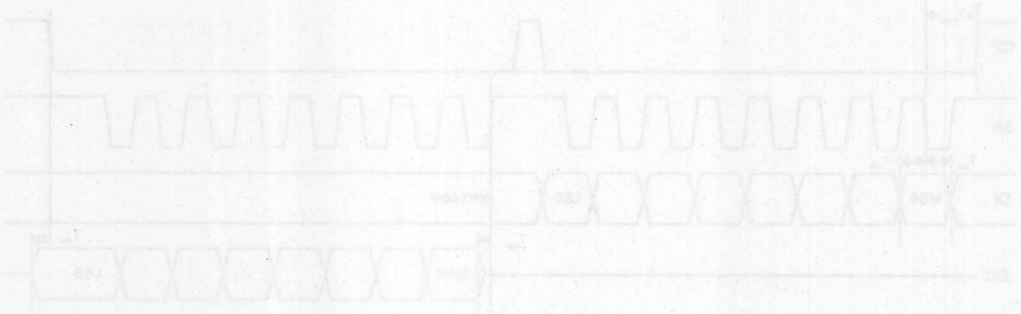
3 - 160

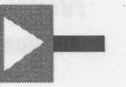
AD280 - Example of Data Read & Write Cycles



- **Simple Serial Interface Requires As Few As Three Lines to Operate**
- **Bytewise Organization Allows the Use of Microcontrollers Internal Shift Capability**

3 - 161

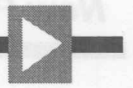




SECTION 4
DIGITAL-ANALOG CONVERTERS

High Speed - Interpolating
High Speed - High Resolution
Direct Digital Synthesis
QPSK/QAM Modulator
General Purpose
Single Supply, Low Power

High Speed D/A Converters

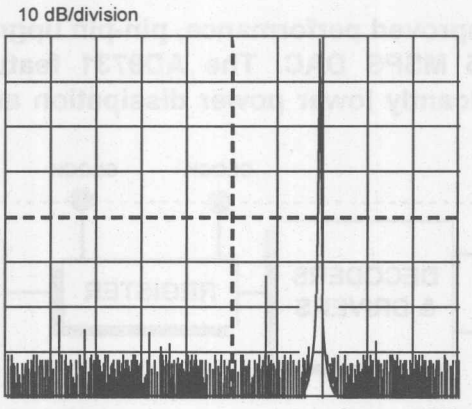


Which Specs are Important for High Speed DACs?

- **High Speed DACs Traditionally Characterized by, -**
  - **DNL, INL, Monotonicity**
  - **Settling Time**
  - **Glitch Impulse**

- **Specs not Sufficient for Communications and Video Imaging Applications**

Important High Speed DAC Specs (con't)



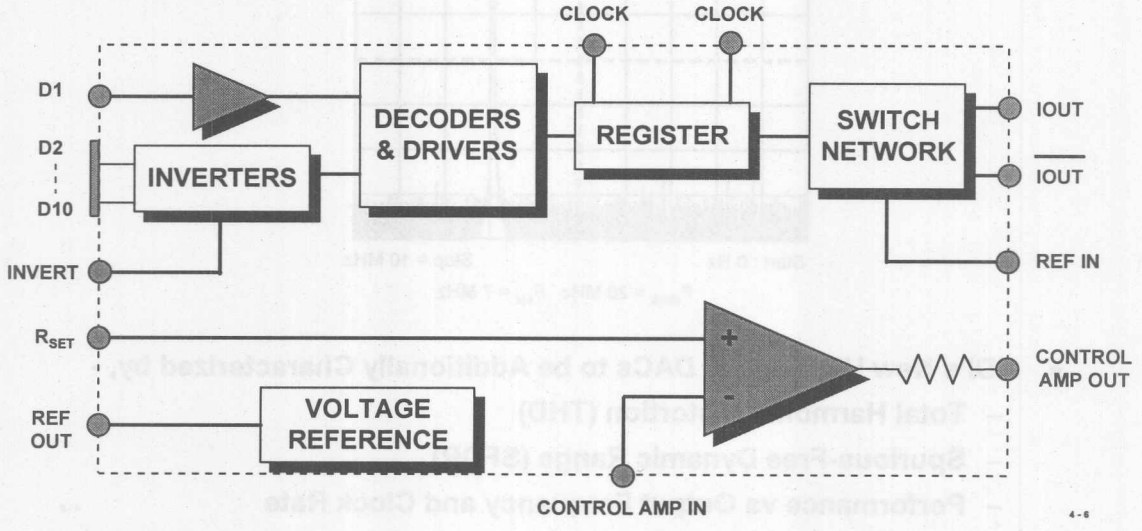
- **ADI's New High Speed DACs to be Additionally Characterized by, -**
  - **Total Harmonic Distortion (THD)**
  - **Spurious-Free Dynamic Range (SFDR)**
  - **Performance vs Output Frequency and Clock Rate**

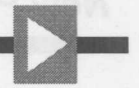
4-5

Preliminary Information

AD9731
10-Bit, 125 MSPS D/A Converter

The AD9731 is an improved performance, pin-pin upgrade to our popular AD9721 10 bit, 125 MSPS DAC. The AD9731 features improved AC performance, significantly lower power dissipation and lower cost than the AD9721.

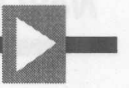




Key Specs and Features...

- Pin-compatible with AD9721
- Improved Spurious-Free Dynamic Range:
  - - 75 dBc @ 2 MHz
  - - 66 dBc @ 40 MHz vs 25 MHz (AD9721)
- Very Low Glitch Impulse : 1.5 pV-sec
- Single +5V Supply
- Reduced Power Consumption:
  - 275 mW @ 125 MSPS vs 1.2 W (AD9721)
- TTL Compatible
- 28 Pin SOIC and SSOP Packaging

4-7



High Speed, 8-14 Bit TxDAC™ ("Transmit DAC") Family

New AD97XX TxDAC[tm] ("Transmit DAC") Family

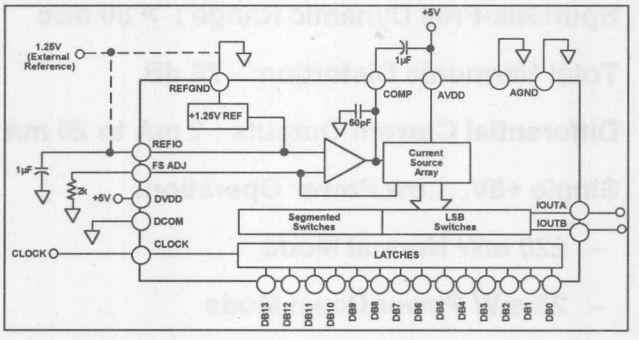
Analog Devices' New AD97XX TxDAC[tm] ("Transmit DAC") Family of 8-14 Bit, 50-125 MSPS DACs are Design-Optimized and Characterized for Communications and Video Imaging Applications, and Feature...

- **Superior Dynamic Performance : 60-70 dB SFDR**
- **Single 3V-5V or 5V Operation**
- **CMOS, Low Power : < 75 mW with 3V Supply**
- **Family Pin Compatibility**
- **Low Cost**
- **Small 28 pin SOIC, TSSOP Packages**

Preliminary Information

AD975X
10-14 Bit, 125 MSPS, TxDAC[tm] Family

The AD975X Family represents Analog Devices' 2nd generation TxDAC™ series of high performance, low power CMOS D/A Converters



- AD9750.....10 bit
- AD9752.....12 bit
- AD9754.....14 bit

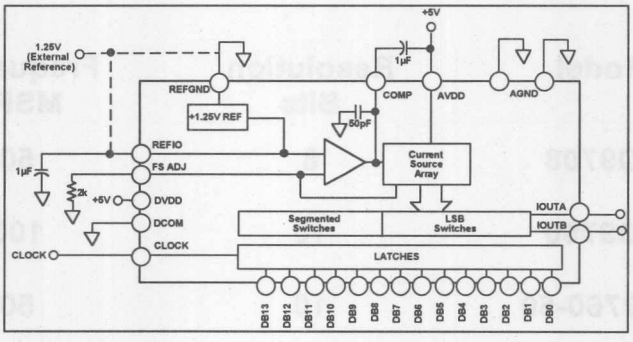
4 - 11

AD975X Family - Key Specs and Features

- 35 ns Settling Time to 0.1 %
- Low Glitch Impulse : 5 pV-sec
- Spurious-Free Dynamic Range : > 80 dBc
- Total Harmonic Distortion: - 76 dB
- Differential Current Outputs : 2 mA to 20 mA
- Single +5V, Low Power Operation:
  - 220 mW Normal Mode
  - 25 mW Power Down Mode
- On-Chip 1.2 V Reference
- Pin Compatibility within TxDAC™ Family
- 28 Pin SOIC, TSSOP Packages

4 - 12

AD9764
14 Bit, 80 MSPS TxDAC[tm]



- 15 ns Settling Time
- Low Glitch Impulse : 5 pV -s
- -53 dB min THD @ F_{out} = 10 MHz
- Internal 1.25V Reference
- Single +3V or +5V Operation:
  - 250 mW Normal Mode
  - 30 mW Power Down Mode
- 28 Pin SOIC Package

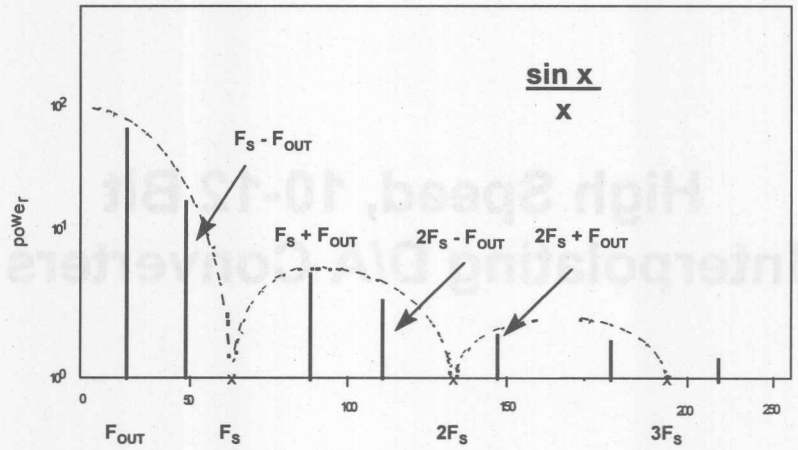
4 - 13

Other Members of the TxDAC™ Family...

Model	Resolution Bits	Frequency MSPS
AD9708	8	50
AD9760	10	100
AD9760-50	10	50
AD9762	12	100
AD9764	14	80

High Speed, 10-12 Bit Interpolating D/A Converters

DAC Images

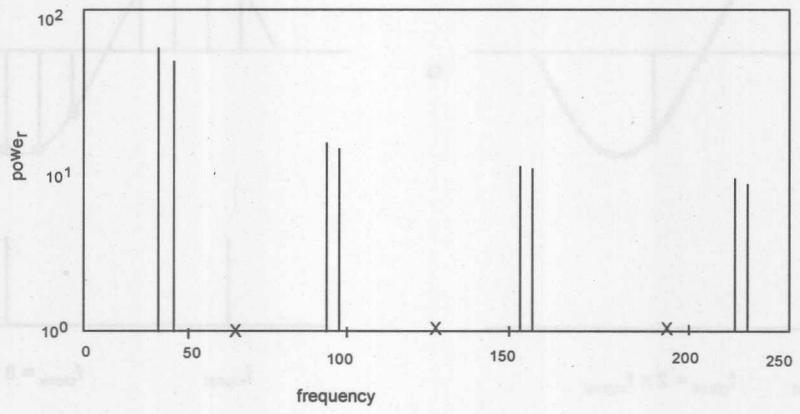


The output of a reconstruction DAC contains "images" (similar to "aliasing" in an ADC...remember Nyquist Theory?) that are multiples of the clock or sampling frequency ± the DAC output, F_{OUT}.

In the above example, $F_{OUT} = 0.29 \times F_S$

4 - 16

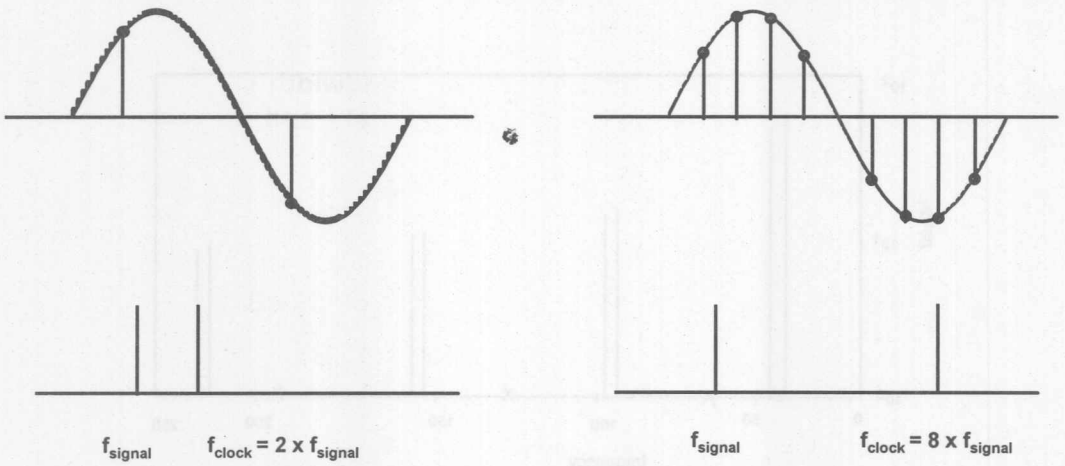
DAC Images (Con't)



As the DAC output (F_{OUT}) approaches Nyquist frequency (in the above example $F_{OUT} = 0.45 \times F_S$) the images become closer together, making it extremely difficult to filter the image from the signal.

4-17

Interpolation



- Maximum output frequency of standard DAC is $F_{clock} \div 2$ (Nyquist Rate)
- In Interpolation, the output DAC runs at x times the clock rate...this produces an image at x times F_{signal}, , smoothing the sine function and simplifying the filter requirements

4 - 18

Preliminary Information

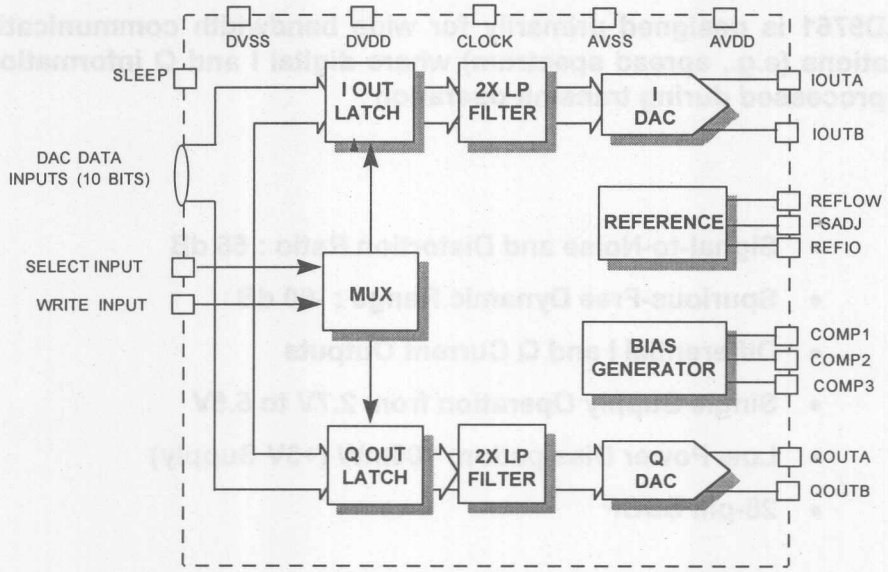
AD9761
Dual 10-Bit, 2X Interpolating TxDAC™

The AD9761 is designed primarily for wide bandwidth communications applications (e.g., spread spectrum) where digital I and Q information is being processed during transmit operation

- **Signal-to-Noise and Distortion Ratio : 55 dB**
- **Spurious-Free Dynamic Range : -60 dB**
- **Differential I and Q Current Outputs**
- **Single Supply Operation from 2.7V to 5.5V**
- **Low Power Dissipation: 100mW (+3V Supply)**
- **28-pin SSOP**

4 - 19

AD9761 Block Diagram



4 - 20

Preliminary Information

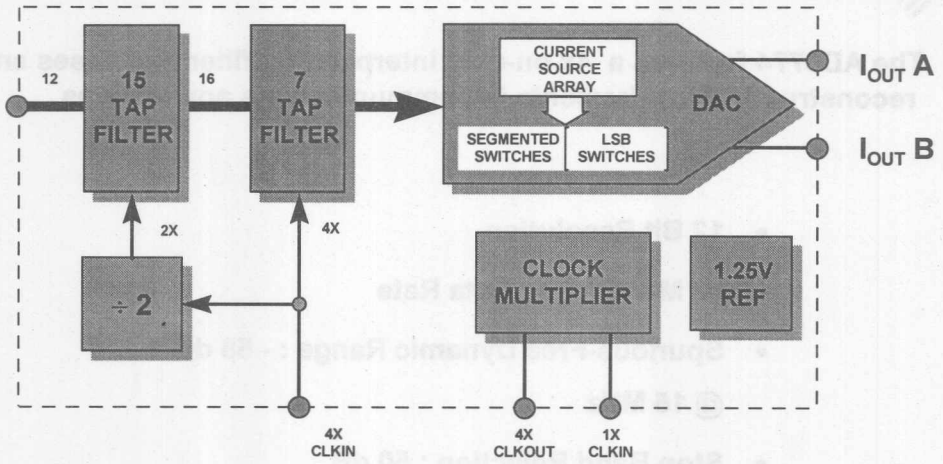
AD9774
12 Bit, 4X Interpolating TxDAC[tm]

The AD9774 features a 4x on-chip Interpolation filter that eases analog reconstruction requirements in communications applications

- **12 Bit Resolution**
- **32 MSPS Input Data Rate**
- **Spurious-Free Dynamic Range : - 58 dBc @ 15 MHz**
- **Stop Band Rejection : 50 dB**
- **Passband Ripple : 0.1 dB**

4 - 21

AD9774 - Block Diagram



- *15 ns Full Scale Settling to 1/2 LSB*
- *35 pV-s Glitch Impulse*
- *Single +5V Operation - <500 mW*

4 - 22

Introducing the *New and Improved* AD768 16 Bit, 40 MSPS Low Glitch D/A Converter!

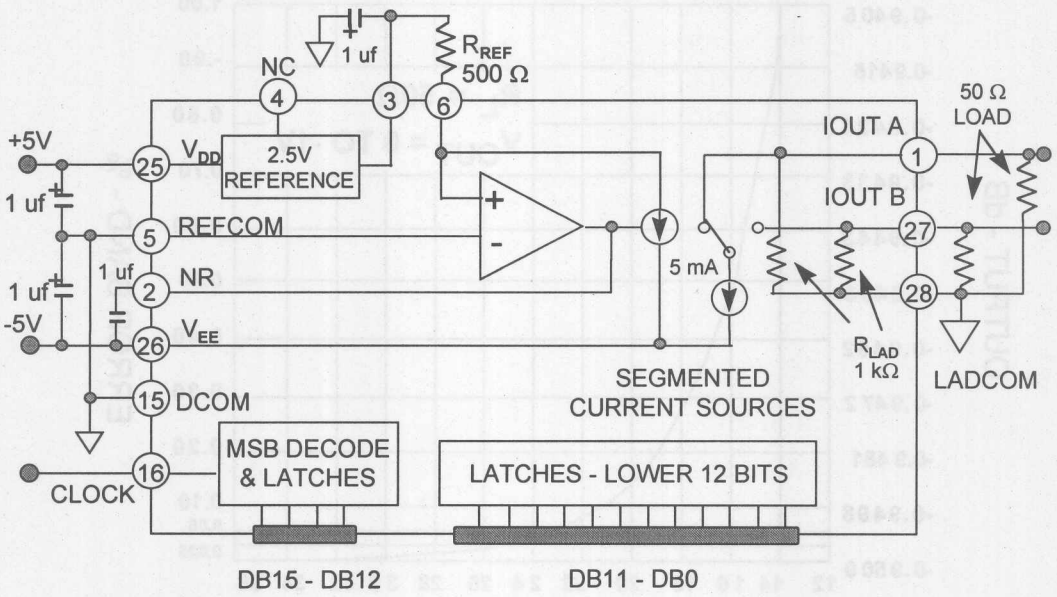
AD768 "B"
16-Bit, 40 MSPS D/A Converter

The AD768 "B" is an enhanced performance version of our AD768...it is a high speed, low glitch, current output DAC that is fully characterized for both AC and DC performance. Its exceptional price/ performance value makes it the DAC of choice in high speed applications.

- **Highest Performance 16-Bit, 40 MSPS DAC**
- **Improved Dynamic Performance**
  - **THD @ 1MHz: -71 dB vs -67 dB (old rev)**
  - **SFDR @ 1MHz: -86 dB vs -83 dB (old rev)**
- **Low Glitch Impulse: 35 pV-s**
- **Fast Settling: 25 ns to 0.025 % Full Scale**
- **20 mA Output Current, 1 kΩ Impedance**
- **On-Chip, Temperature Compensated 2.5V Reference**
- **Low Power Operation: ± 5V, Consumes Only 500 mW**

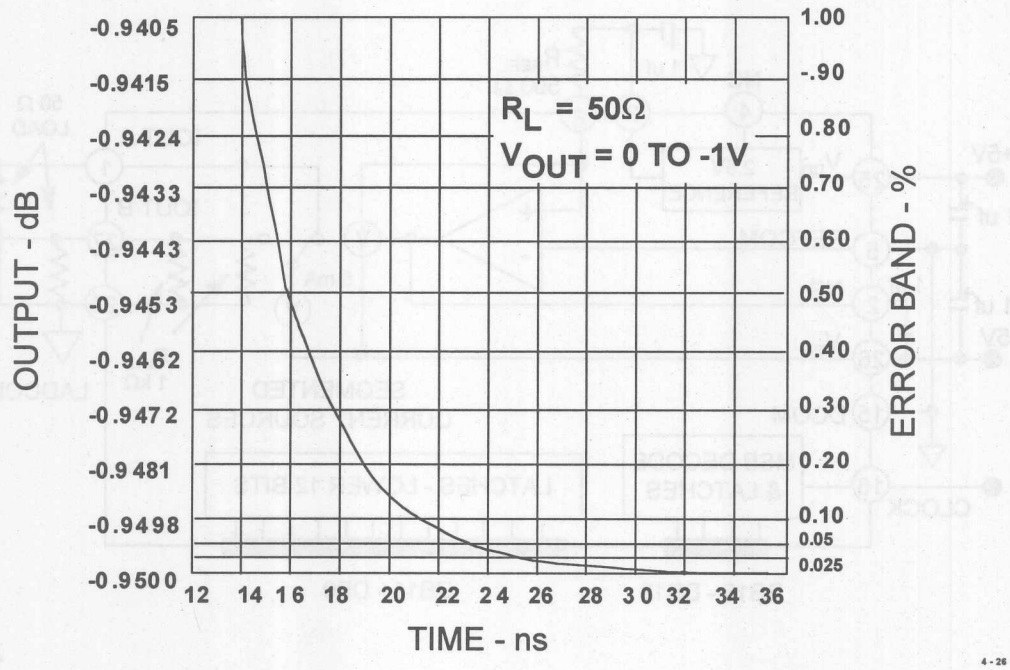
4 - 24

Functional Block Diagram and Basic Hookup



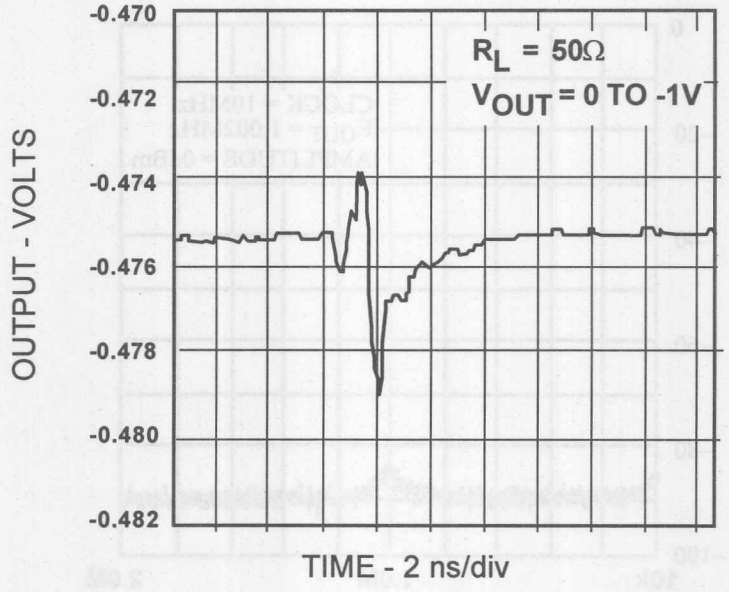
4 - 25

AD768 - Settling Time



4-26

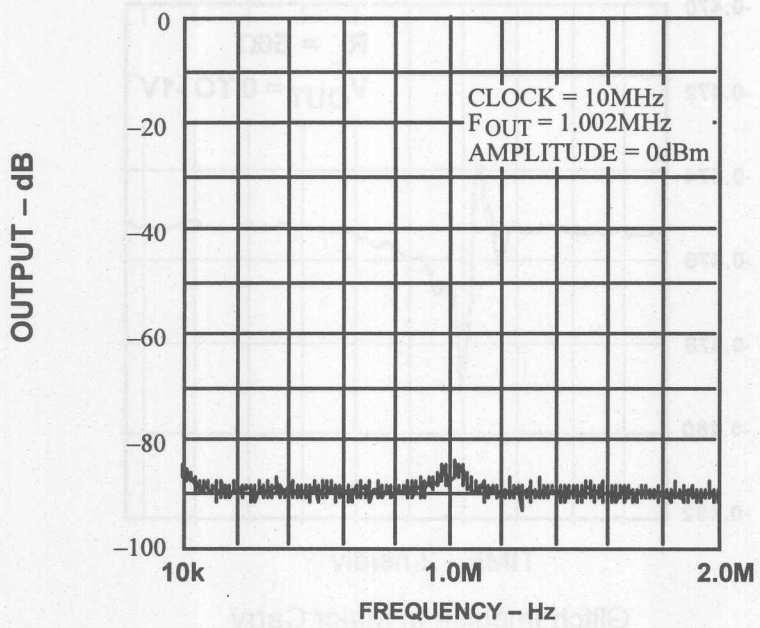
AD768 - Glitch Impulse



Glitch Impulse at Major Carry

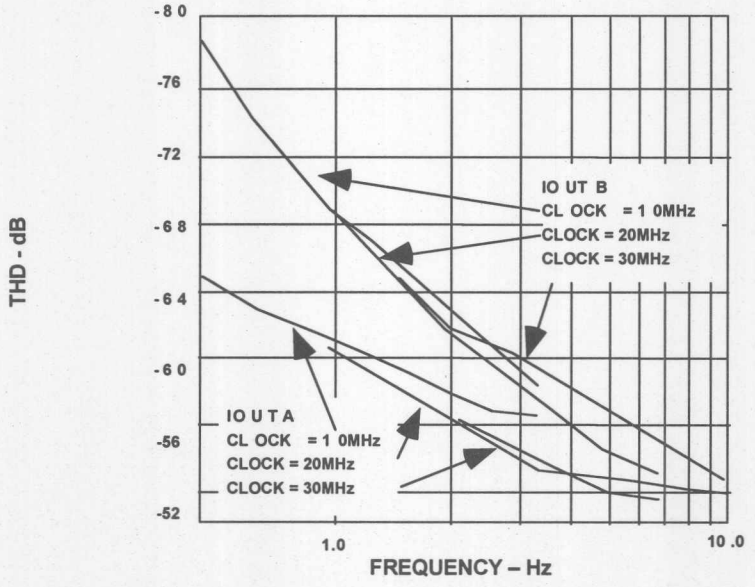
4-27

AD768 - Spurious Free Dynamic Range



4 - 28

AD768 - Total Harmonic Distrortion



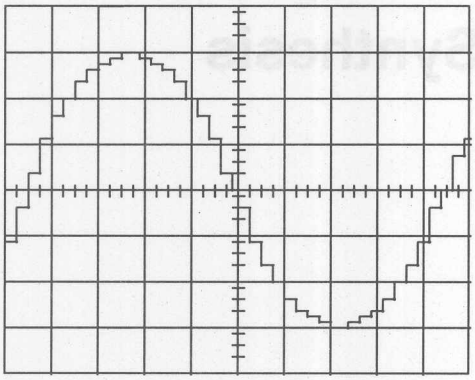
Total Harmonic Distortion vs Input Frequency

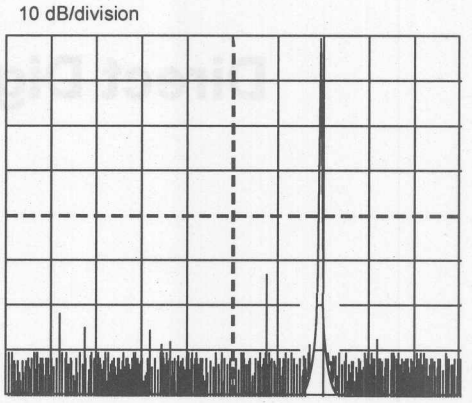
4 - 29

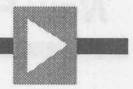
Direct Digital Synthesis

What is Direct Digital Synthesis?

Direct Digital Synthesis (DDS) is a technique which allows one to generate high frequency, spectrally pure sinewaves of varying frequencies.





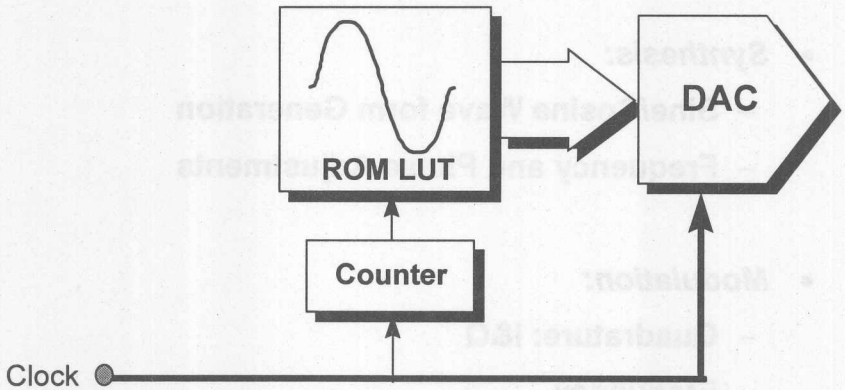


Where is Direct Digital Synthesis Used?

- ***Synthesis:***
  - **Sine/Cosine Wave form Generation**
  - **Frequency and Phase Adjustments**

- ***Modulation:***
  - **Quadrature: I&Q**
  - **Frequency**
  - **Phase**
  - **Amplitude**

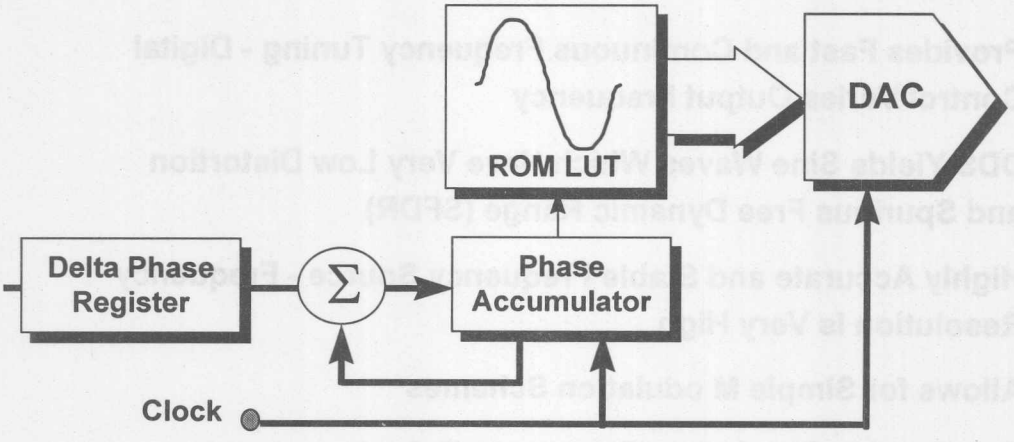
Basic Waveform Generator



- On each cycle of the clock, the address pointer moves by one position in the Look Up Table (LUT) and the DAC is updated, which yields a sine wave of constant frequency.
- But how can we vary the output frequency without having to vary the clock speed?

4 - 34

Phase Accumulator



The frequency of the sinewave depends on the step size of the phase accumulator, so we actually write a phase increment to the device (not a frequency)

4 - 35

Advantages of Direct Digital Synthesis

- **Provides Fast and Continuous Frequency Tuning - Digital Control Varies Output Frequency**
- **DDS Yields Sine Waves Which Have Very Low Distortion and Spurious Free Dynamic Range (SFDR)**
- **Highly Accurate and Stable Frequency Source - Frequency Resolution Is Very High**
- **Allows for Simple M odulation Schemes**
- **Can Provide Quadrature Frequency Outputs**

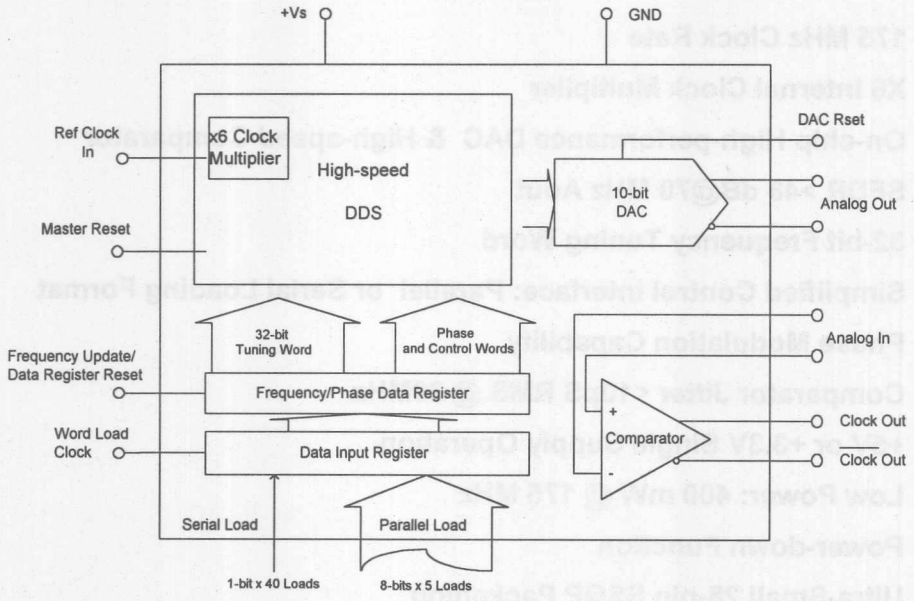
Preliminary Information

AD9851
175 MHz Direct Digital Synthesizer

- 175 MHz Clock Rate
- X6 Internal Clock Multiplier
- On-chip High-performance DAC & High-speed Comparator
- SFDR >48 dB@70 MHz Aout
- 32-bit Frequency Tuning Word
- Simplified Control Interface: Parallel or Serial Loading Format
- Phase Modulation Capability
- Comparator Jitter <10pS RMS @ 20MHz
- +5V or +3.3V Single Supply Operation
- Low Power: 400 mW @ 175 MHz
- Power-down Function
- Ultra-Small 28-pin SSOP Packaging

4 - 37

AD9851 Block Diagram



Frequency, Phase, and Control Data Input

4 - 38

AD9830, AD9831, AD9832 and AD9850
CMOS Direct Digital Synthesizers

AD9850 :

- 125 MHz
- Stable Clock Output : < 20 ps RMS Jitter @ 20 MHz
- I and Q Outputs

AD9830 :

- 50 MHz
- I and Q Outputs
- +5V Supply

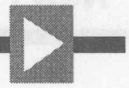
AD9831 :

- 25 MHz
- 3V Operation, 35 mW
- I Output

AD9832 :

- Serial Version of AD9831
- 16-Pin TSSOP Package

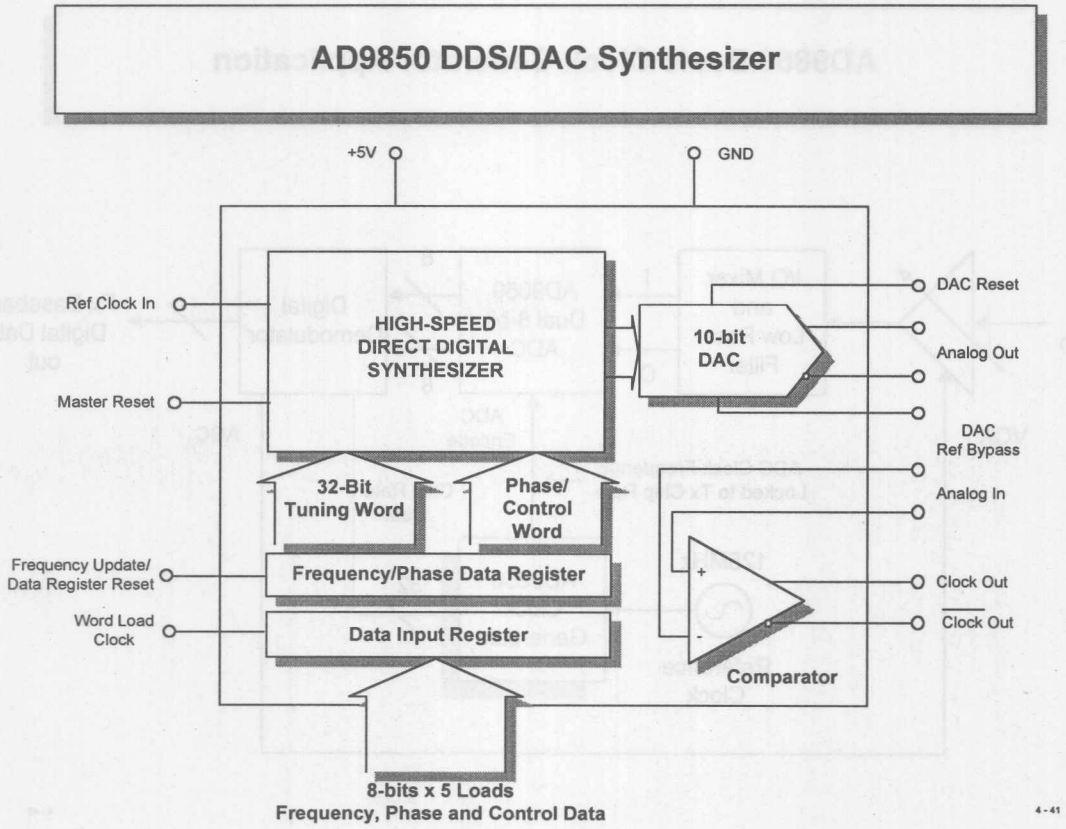
4 - 39



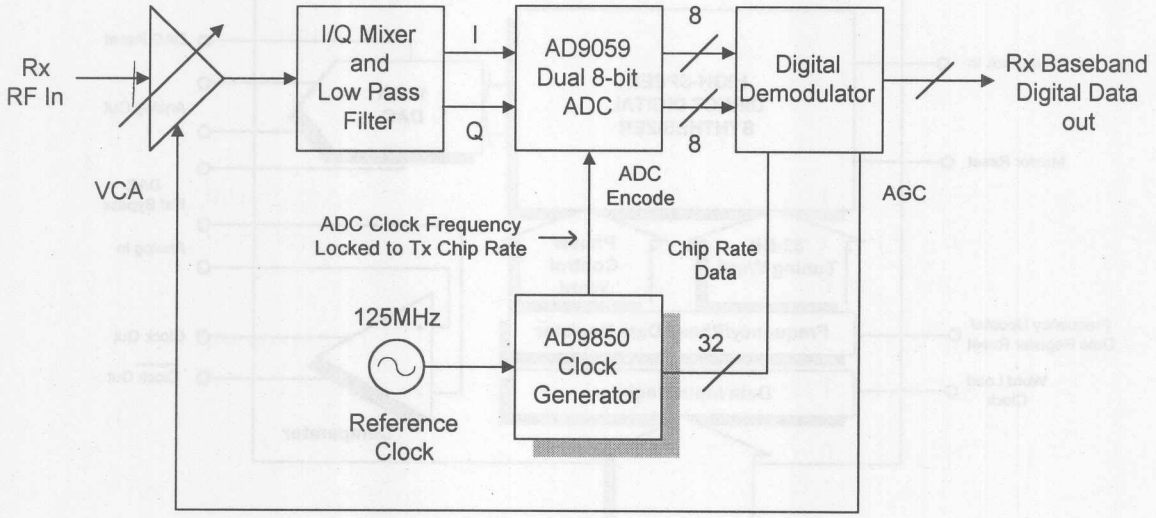
AD9830, AD9831 and AD9850 - Key Model Differences

	AD9830	AD9831	AD9850
Clock Rate, MHz	50	25	125
Clock Comparator	no	no	yes
Loading	16 x 2	16 x 2	8 x 4
Output(s)	2	1	2
Power Supply	+5V	+3V, +5V	+5V
Consumption	250 mW	35/150 mW	380 mW
Power Down	yes	yes	yes
SFDR	50 @ 2 MHz	55 @ 1 MHz	60 @ 1 MHz
Package	48 pin TQFP	48 pin TQFP	28 pin SSOP

4 - 40


AD9850 DDS/DAC Synthesizer
+5V
GND
Ref Clock In
Master Reset
HIGH-SPEED
DIRECT DIGITAL
SYNTHESIZER
10-bit
DAC
DAC Reset
Analog Out
DAC
Ref Bypass
Analog In
32-Bit
Tuning Word
Phase/
Control
Word
Frequency Update/
Data Register Reset
Frequency/Phase Data Register
Word Load
Clock
Data Input Register
+
-
Clock Out
Clock Out
Comparator
8-bits x 5 Loads
Frequency, Phase and Control Data
4-41

AD9850 Basic Clock Generator Application



4 - 42

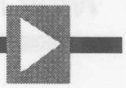
AD9850 vs AD9955

- The AD9850 may be used to replace the obsoleted AD9955 DDS device in most applications, but not all of them.

AD9850/AD9955 differences...

- The AD9850 has an integrated 10-bit DAC and brings the reconstructed analog Sine out. The AD9955 doesn't include a DAC and brings 12-bits out in digital form.
- SFDR (DAC output) for the AD9850 is >70dB @ 1MHz/>50dB @ 40MHz; the AD9955 spec's 90dB (digital data out).
- Package/pinout differences

4 - 43



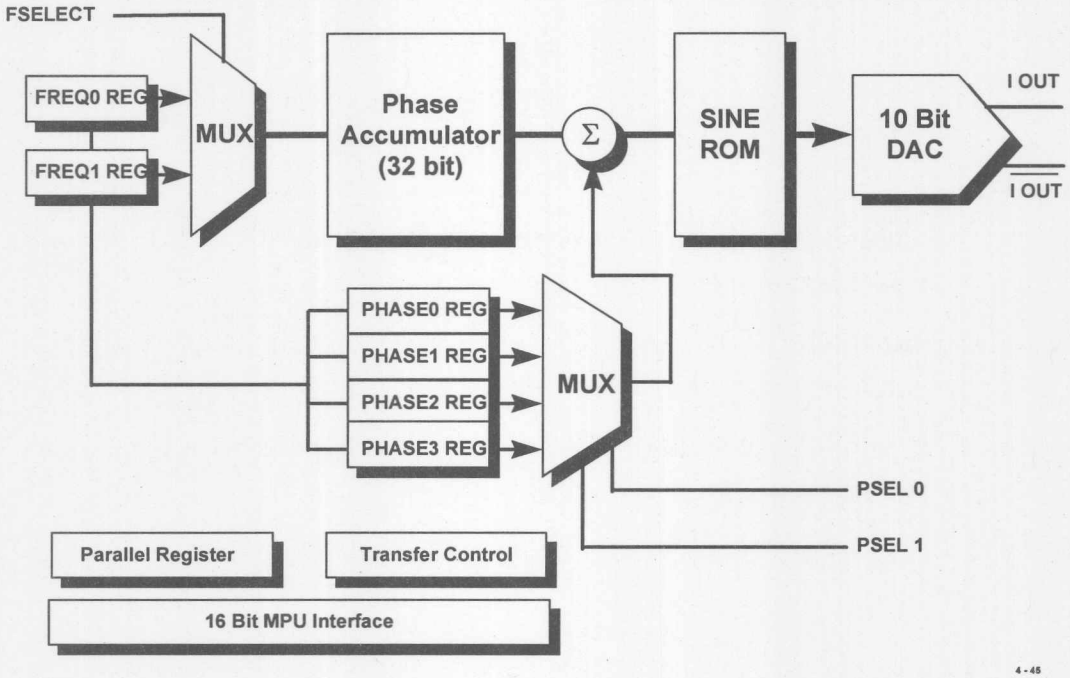
AD9850 Evaluation Boards

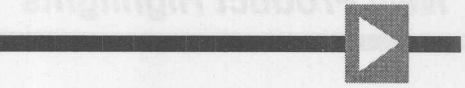
Two versions of AD9850 evaluation board are available:

- **AD9850/FSPCB - Optimized for output frequency analysis (internal comparator disabled).**
- **AD9850/CGPCB - Optimized for clock generator application with LP filter included from DAC out to comparator in.**
- **Both versions are $98.50 (U.S.) and include the device and Windows-compatible software.**

4 - 44

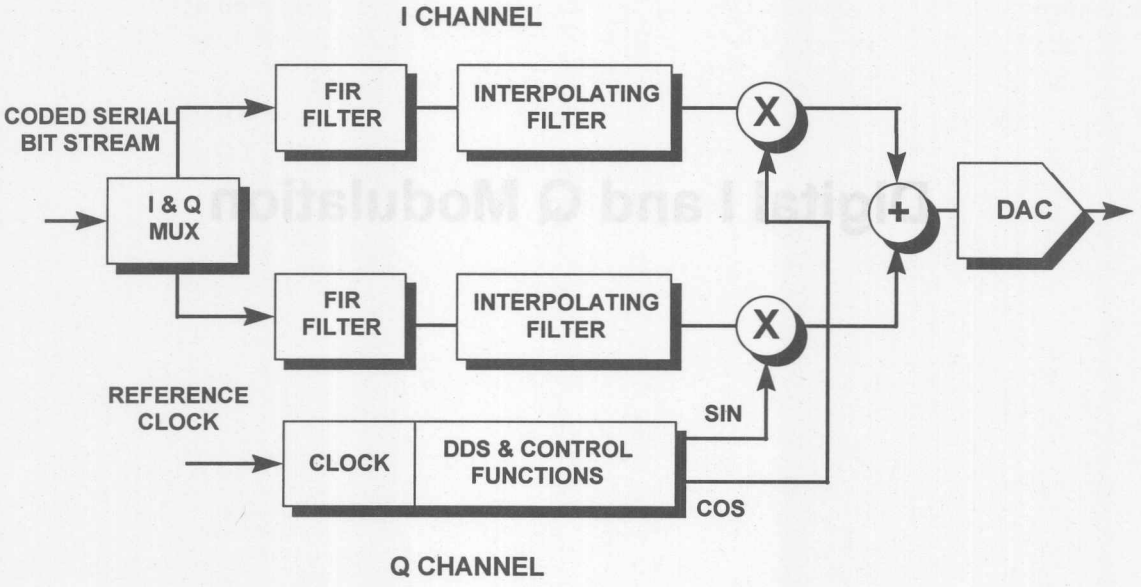
AD9830, AD9831 Block Diagram





Digital I and Q Modulation

A Typical I and Q Modulator

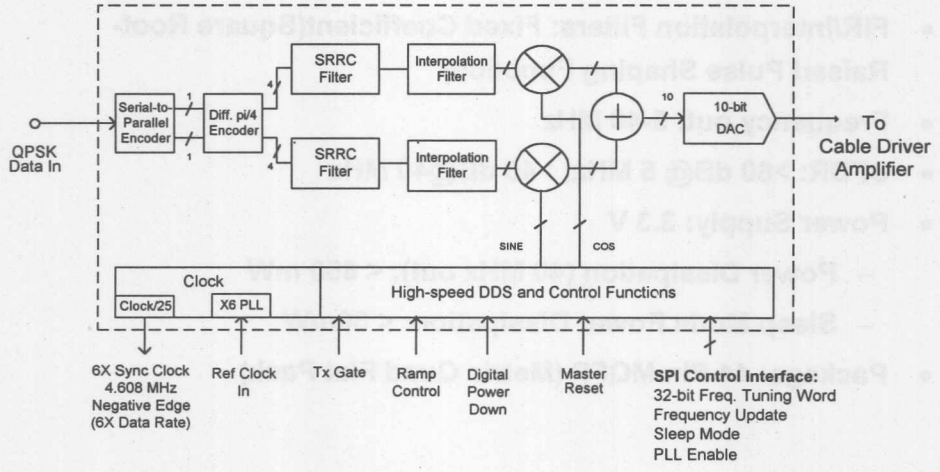


4 - 48

Preliminary Information

AD9853
Digital QPSK/16-QAM Modulator

The AD9853 is a complete solution for return path HFC (Hybrid Fiber Coax) systems allowing the capability for interactive video and high-speed data subscriber services in set-top box applications. The AD9853BR-1 is the basic modulator, while the AD9853BR-2 adds digital programmability



4 - 49

AD9853 - Key Specs and Features

- 115.2 MHz Clock Rate
- Frequency Tuning Word: 32-bit Serial Load
- Burst Mode Function
- FIR/Interpolation Filters: Fixed Coefficient(Square Root-Raised Pulse Shaping Function)
- Frequency out: 5-40 MHz
- SFDR: >60 dB@ 5 MHz; >46 dB@40 MHz
- Power Supply: 3.3 V
  - Power Dissipation (40 MHz out): < 650 mW
  - Sleep Mode Power Dissipation: < 30mW
- Package: 44 Pin MQFP (Metric Quad Flat Pack)

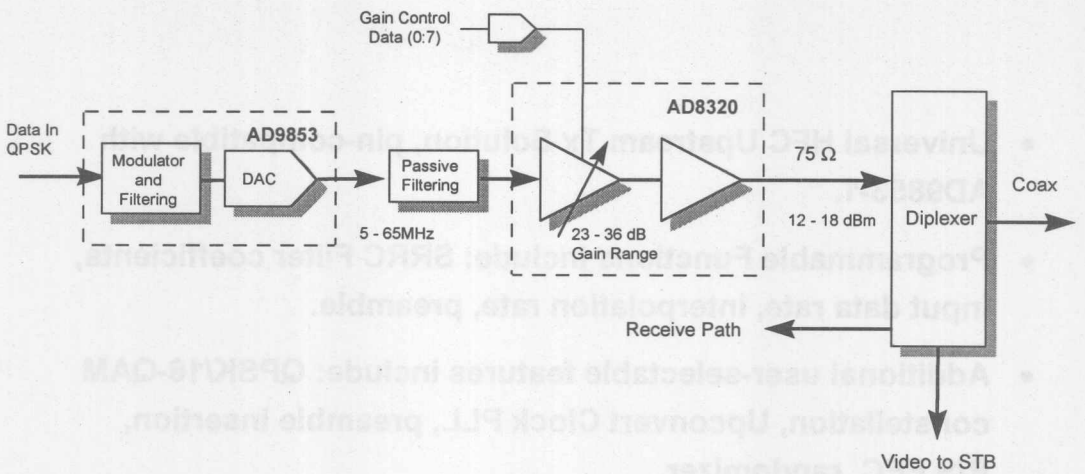
Preliminary Information

AD9853BR-2
Programmable Digital Modulator

- Universal HFC Upstream Tx Solution, pin-compatible with AD9853-1.
- Programmable Functions Include: SRRC Filter coefficients, input data rate, interpolation rate, preamble.
- Additional user-selectable features include: QPSK/16-QAM constellation, Upconvert Clock PLL, preamble insertion, R/S FEC, randomizer.

4 - 51

AD9853 and AD8320 in Cable Modems



THE AD9853 & AD8320 in an Application for up-Stream Transmit in Subscriber-End Cable Modems

4 - 52

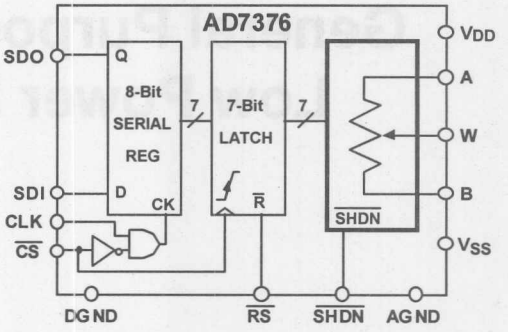
General Purpose, Single Supply, Low Power D/A Converters

Preliminary Information

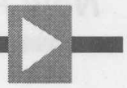
AD7376
Rail-to-Rail, 7-Bit Digital Potentiometer

The AD7376 offers the highest voltage operation digital potentiometer available on the market today!

- **+5 to +28V Single Supply**
- **±5 to ±15V Dual Supply**
- **128 Position**
- **10K, 50K, 100K, 1M Ohm**
- **SPI Compatible 3-Wire Interface**
- **14 Pin DIP, 16 Pin Narrow Body SOIC, and 14 and 16 Pin (1.1 mm height) TSSOP Packages**



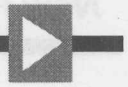
4-54



Analog Devices is Proud to Announce A New Series of Single Supply, Low Power 8-12 Bit Voltage Output D/A Converters

These New D/A Converters Feature...

- *Single Supply Operation from 2.7V to 5.5V*
- *Very Low Power Consumption, typ < 200 uA*
- *High Speed (30 MHz!) Serial Interface Compatible with SPI™, QSPI™ and Microwire™ Protocols*
- *Power Down Mode < 1 uA*
- *Rail-Rail Voltage Outputs*
- *Plus Much, Much More...*



The ADI DAC Family Portfolio...

- **AD7302, AD7303**
  - 8 Bit Dual Parallel/Serial
  - Fastest Settling Time , < 2 us
  - Low est Glitch , 1 nV-sec
- **AD7304, AD7305**
  - 8 Bit Quad Parallel/Serial
  - Highest Multiplying Bandwidth, 2 MHz
- **AD7801**
  - Single Version of AD7302 8 Bit Parallel

The ADI DAC Family Portfolio (con't)...

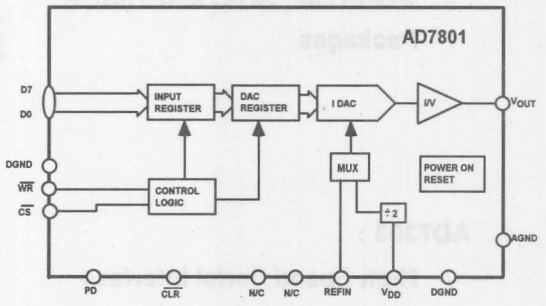
- **AD7394, AD7396**
  - Dual 12 Bit Serial/Parallel
  - Lowest Power, < 100 uA
  - RESET to zero or Mid-Scale
- **AD7395, AD7397**
  - 10 Bit Versions of AD7394, AD7396
  - RESET to Zero
  - - 40 deg C to + 125 deg C

The ADI DAC Family Portfolio (con't)...

- AD5300/10/20
  - 8/10/12 bit Serial
  - Low Power, < 250 uA
  - -40 deg C to + 105 deg C
- AD5302/12/22
  - Dual Versions of AD5300/10/20
  - SW Programmable Power Down Modes
  - Buffered REF Inputs
  - SW Programmable REF Buffer On/Off
- AD5303/13/23
  - Dual Versions of AD5300/10/20
  - HW Programmable REF Buffer On/Off
  - HW Programmable CLR
  - Serial Data Out for Daisy Chain Mode

AD7801
8 Bit Rail-Rail Parallel D/A Converter

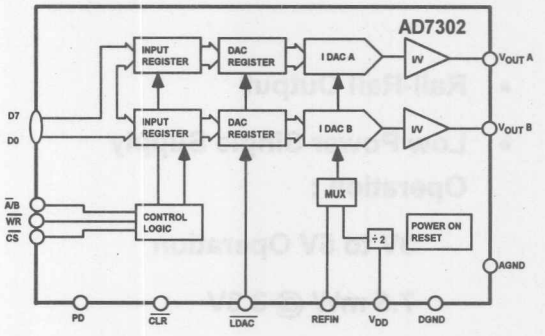
- **Rail-Rail Output**
- **Low Power Single Supply Operation :**
  - **3V to 5V Operation**
  - **7.5 mW @ 3.3V**
  - **Power Down Option**
- **Automatic Selection of REF IN or $V_{DD}/2$ as the Reference**
- **Synchronous Update**
- **20 Pin DIP Package**



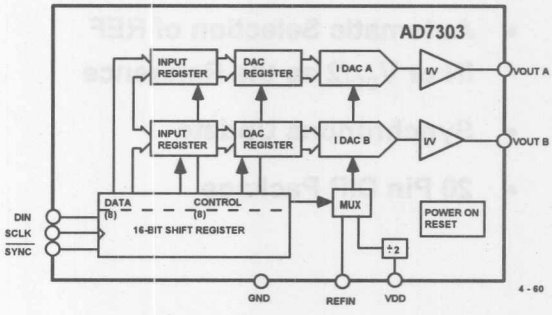
4 - 59

AD7302 and AD7303
Dual, 8 Bit Rail-Rail Parallel/Serial D/A Converters

- **AD7302 :**
  - **High Speed Parallel Interface**
  - **20 Pin DIP, SOIC and TSSOP Packages**



- **AD7303 :**
  - **High Speed Serial Interface**
  - **SPI™, QSPI™ and Microwire™ Compatible, 30 MHz Clock**
  - **8 Pin SOIC and μSOIC Packages**



Both Models Feature...

- Precision Voltage Amplifier Provides True Rail-Rail Outputs with Fast, 1.2 us Settling Time
- Automatic Selection of REF IN or $V_{DD}/2$ as the Reference
- Power On RESET Feature Loads all Zeros Until WR Command
- Software - Controlled POWER DOWN Feature :
  - DACs May Be Powered Down Separately or Together
- Low Power, Single Supply Operation :
  - 2.7 V to 5.5 V Operation
  - < 10 mW @ 3.3V, < 3.3 uW in Power Down Mode
- Automotive Temp Range : -40 deg C to +105 deg C

4 - 61

Preliminary Information

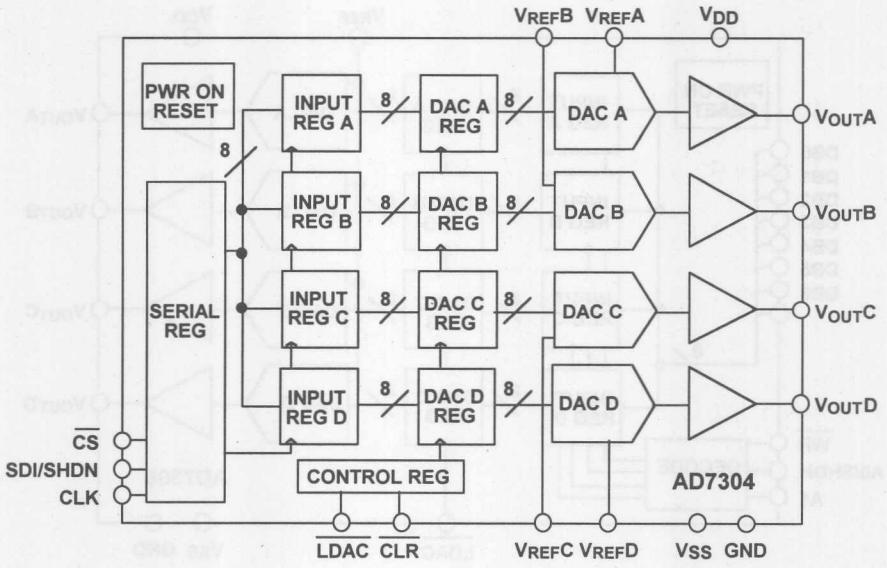
AD7304, AD7305
8 Bit, Quad, Serial/Parallel D/A Converters

The AD7304 and AD7305 are essentially quad versions of the AD7302 and AD7303, respectively, except as noted...

- **+3V, +5V & ±5V Operation**
- **2.6 MHz Reference Multiplying Bandwidth**
- **External Reference Input Range : + V_{DD} to - V_{SS}**
- **Package Styles :**
  - **16/20 Pin DIP, SOIC and Compact 1.1 mm TSSOP**
- **Operating Temp Ranges :**
  - **- 40 deg C to + 85 deg C : DIP, SOIC and TSSOP**
  - **- 40 deg C to + 125 deg C : SOIC**
- **AD7305 Pin Compatible Upgrade of AD7226 when V_{DD}<5.5V**

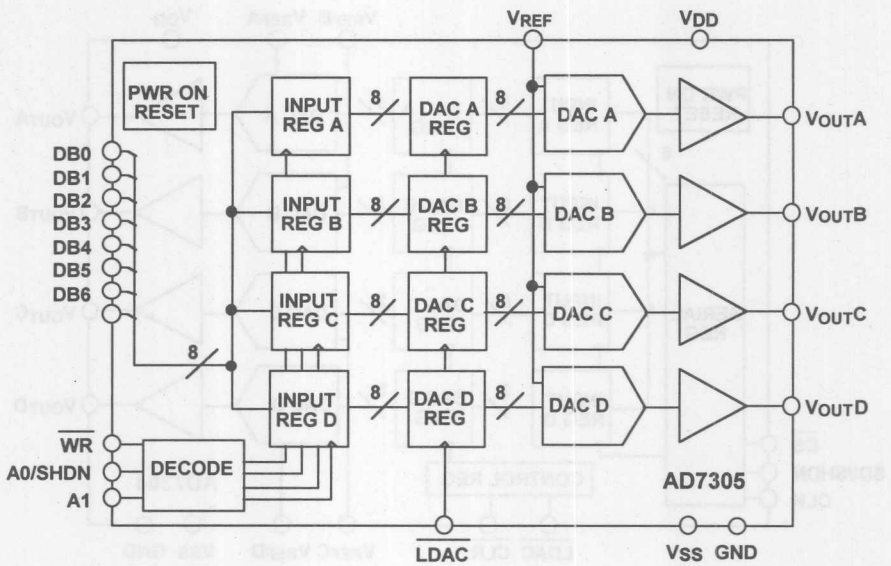
4 - 62

AD7304 - Block Diagram



4-63

AD7305 - Block Diagram



4-64

Preliminary Information

AD7394-AD7397*
10-Bit/12-Bit, Dual, Micropower D-A Converters

- AD7394, AD7395 : 12/10 Bit Serial
- AD7396, AD7397 : 12/10 Bit Parallel
- REF Input Range : 0V to V_{DD}
- True Rail-Rail Output : 0V to V_{REF} Voltage Swing
- Output Amplifier :
  - Sources and Sinks Current
  - 60 us Settling Time
- SPI™ and QSPI™ - Compatible Serial Interface with Schmitt Trigger Inputs, 15 MHz Clock
- Programmable RS/MSB Pins Set Output to Zero or 1/2 Scale
- Pin-Programmable SHDN Reduces Supply Current to typ 100 nA

4 - 65

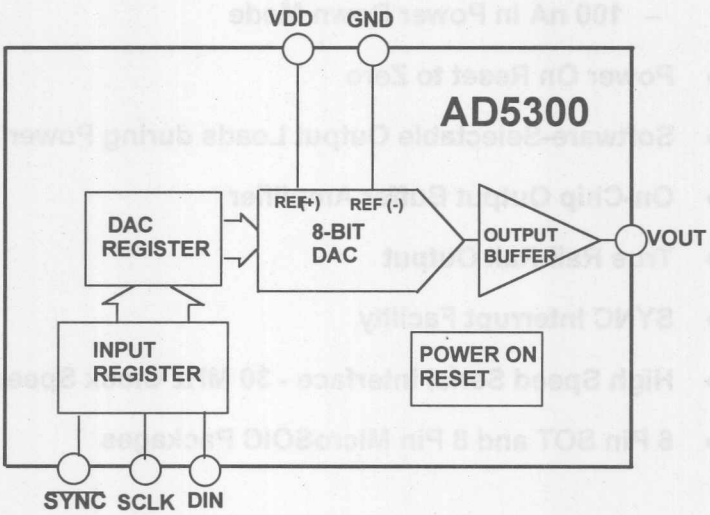
AD7394-AD7397 - Key Specs and Features (con't)

- + 2.7V to + 5.5V Single Supply Low Operation :
  - Less Than 200 uA, Normal Operation
  - Typically 0.1 uA Shutdown Current
- Compact, Low Profile Packaging:
  - AD7394/95 :
    - » 14-Pin DIP, SOIC and 1.1 mm TSSOP-14 (AD7395)
  - AD7396/97 :
    - » 24-Pin DIP, SOIC and 1.1 mm TSSOP-24 (AD7397)
- Operating Temperature Ranges:
  - DIP, SOIC : -40 deg C to + 85 deg C
  - TSSOP : - 40 deg C to + 125 deg C

Preliminary Information

AD5300, AD5310 and AD5320
8/10/12 Bit, Rail-Rail Serial D/A Converters

The AD5300, AD5310 and AD5320 are low cost, 8, 10 and 12 bit D/A Converters that feature a high speed, 3-wire serial interface, and are available in a space-saving 6 pin SOT package!



4 - 67

AD5300/5310/5320 - Key Specs and Features

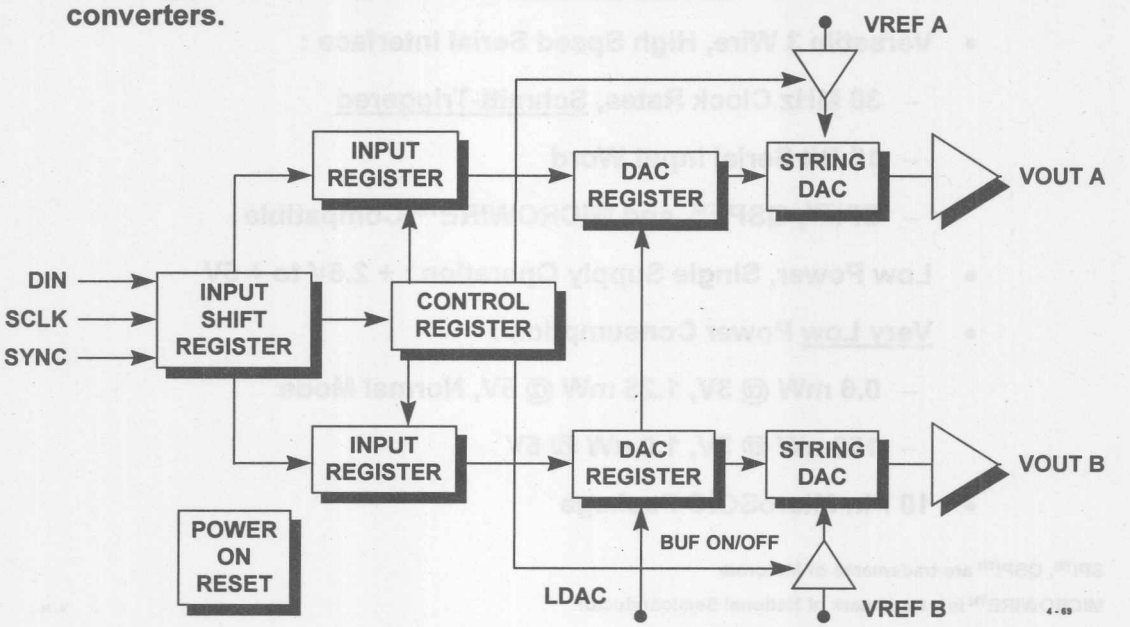
- Single +2.7V to +5V Operation
  - 200 uA Quiescent Current
  - 100 nA in Power Down Mode
- Power On Reset to Zero
- Software-Selectable Output Loads during Power Down Mode
- On-Chip Output Buffer Amplifier
- True Rail-Rail Output
- SYNC Interrupt Facility
- High Speed Serial Interface - 30 MHz Clock Speed
- 6 Pin SOT and 8 Pin MicroSOIC Packages

4 - 68

Preliminary Information

AD5302/5312/5322
8/10/12 Bit, Dual, Rail-Rail Voltage Output D/A Converters

The AD5302 (8 bit), AD5312 (10 bit) and AD5322 (12 bit) are ADI's newest family of high speed, *very low power* , pin-compatible D/A converters.



AD5302, AD5312, AD5322 - Key Specs and Features

- True Rail-Rail Performance - Output Range is 0V to V_{REF}
- Versatile 3 Wire, High Speed Serial Interface :
  - 30 MHz Clock Rates, Schmitt-Triggered
  - 16 Bit Serial Input Word
  - SPI™, QSPI™, and MICROWIRE™ Compatible
- Low Power, Single Supply Operation : + 2.5V to + 5V
- Very Low Power Consumption :
  - 0.6 mW @ 3V, 1.25 mW @ 5V, Normal Mode
  - 150 nW @ 3V, 1.0 uW @ 5V
- 10 Pin MicroSOIC Package

SPI™, QSPI™ are trademarks of Motorola

MICROWIRE™ is a trademark of National Semiconductor

4 - 70

AD5302/12/22 - 16 Bit Serial Input Word Shift Register

DB15 (MSB) ← DATA BITS → DB0 (LSB)

AD5302

A/B	BUF	PD1	PD0	D7	D6	D5	D4	D3	D2	D1	D0	X	X	X	X

AD5312

A/B	BUF	PD1	PD0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	X	X

AD5322

A/B	BUF	PD1	PD0	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

4 - 71

AD5302/12/22 - 16 Bit Shift Register Control Bits

- A/B : Controls Which DAC is Written To:
  - 0 : Data Written to DAC A
  - 1 : Data Written to DAC B
- BUF : Controls Buffered or Unbuffered Operation of Reference
  - 0 : Unbuffered
  - 1 : Buffered
- Power Down Bits (see below)

PD1	PD0	Operating Mode
0	0	Normal Operation
0	1	Power Down (1 kΩ load to GND)
1	0	Power Down (100 kΩ load to GND)
1	1	Power Down (Hi-Z Output)

4 - 72

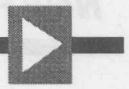
Preliminary Information

AD5303/5313/5323
8/10/12 Bit, Dual, Rail-Rail Voltage Output D/A Converters

The AD5303, AD5313 ands AD5323 are identical in performance to the AD5302, AD5312 and AD5322, respectively, with the following differences:

- **Output Range is Software Selectable for either 0V to V_{REF} or 0V to 2 x V_{REF}**
- **Reference Buffered/Unbuffered Mode is Selected via Control Pin**
- **Serial Data Output (SDO) Allows for Daisy-chaining Several DACs**
- **PD Pin provides Additional Hardware Control of Power Down Mode**
- **CLR (clear) Pin Resets DAC and Input Registers to Zero**
- **16 Pin TSSOP Package**

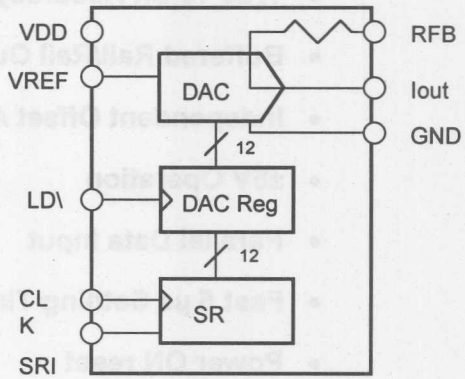
4 - 73



Additional High Performance 12-14 Bit D/A Converters...

DAC8043A
12-Bit 4 Quadrant Multiplying Serial D/A Converter

- **+ 5V Operation @ <10uA**
- **Fast 3-Wire Serial Input**
- **Fast 1 µs Settling Time**
- **>1MHz 4-Quadrant Multiply BW**
- **Pin-for-Pin Upgrade for DAC8043**
- **Standard Pin Out**
- **Compact 8-Pin SOIC & TSSOP Packages**



4-75

Preliminary Information

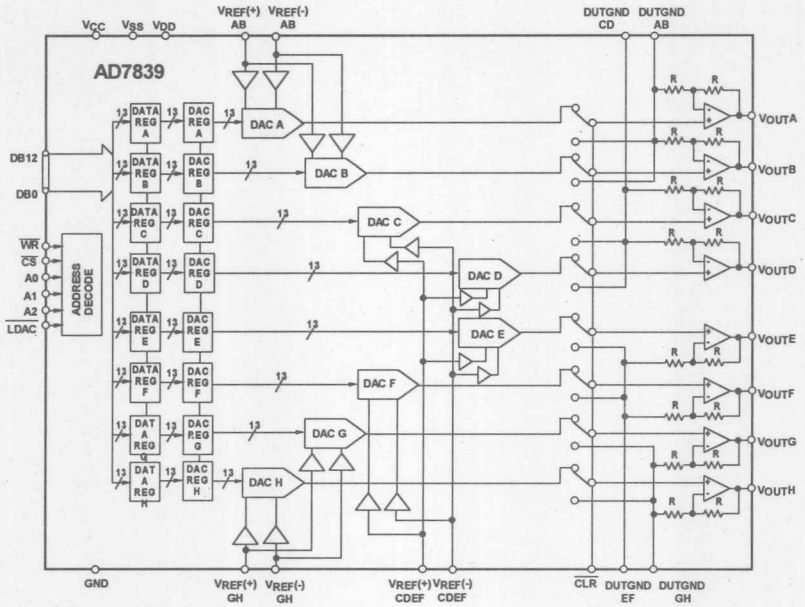
AD7838 and AD7839
13 Bit Octal, Rail-Rail Parallel D/A Converters

The AD7838 and AD7839 contain eight 13-bit D/A Converters in one package!

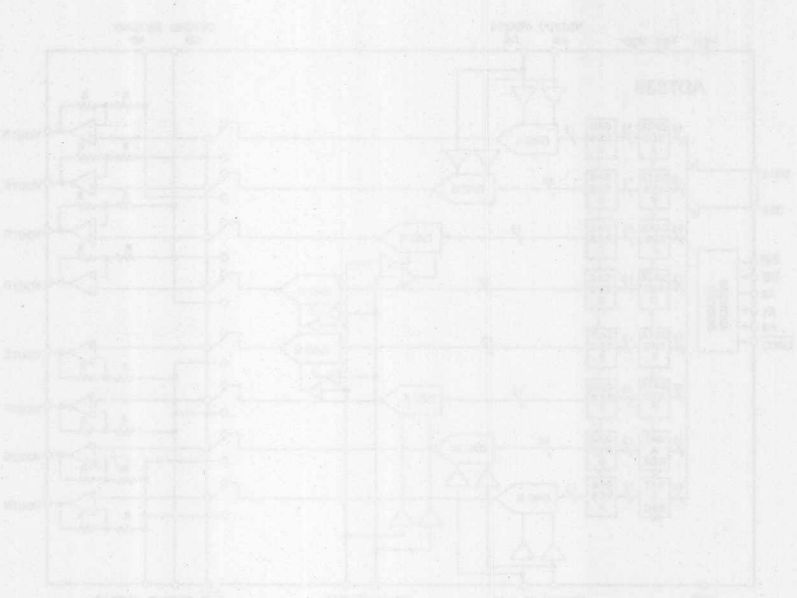
- True 13-bit Accuracy
- Buffered Rail/Rail Outputs : ± 10V
- Independent Offset Adjustment for Each Output
- ±5V Operation
- Parallel Data Input
- Fast 5 µs Settling Time
- Power ON reset
- Separate Reference Inputs : ± 5V
- Compact 44-Pin PQFP Package

4 - 76

AD7839 - Simplified Diagram



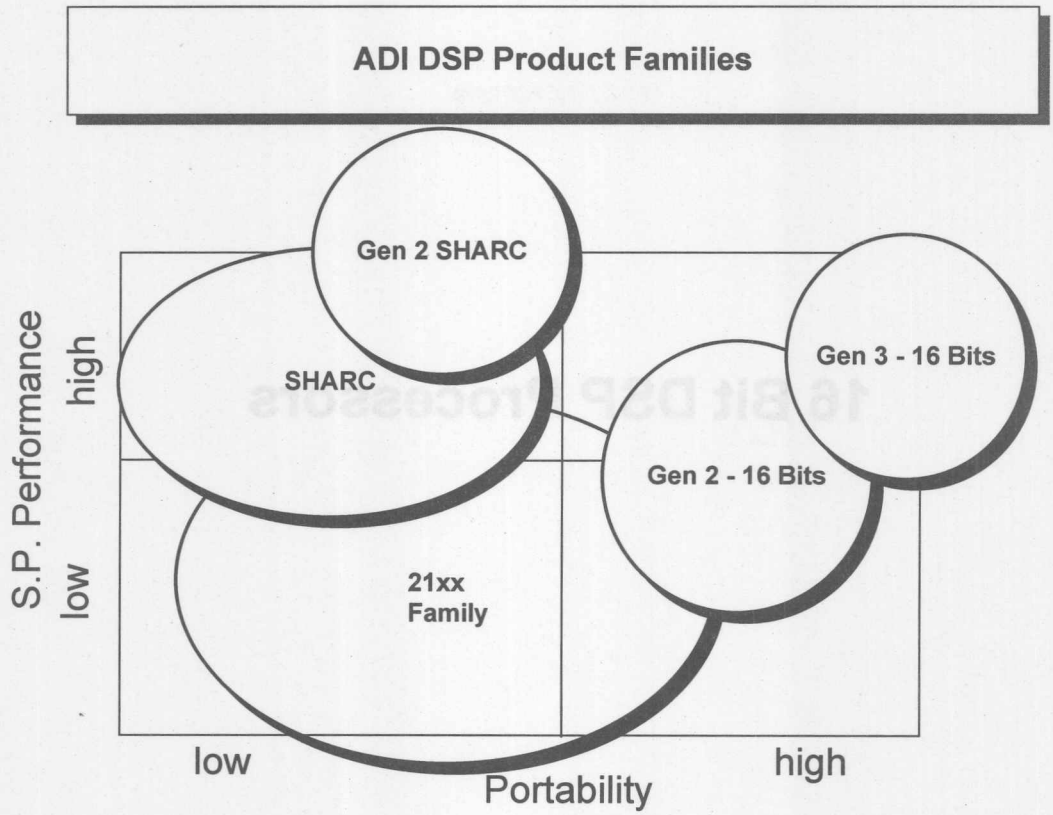
4 - 77

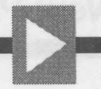


SECTION 5
DIGITAL SIGNAL PROCESSING

- *ADSP-21XX Family 16 Bit DSP Processors*
- *ADSP-21000 Family (SHARC) 32 Bit DSP Processors*
- *RAS (Remote Access Server) Modem Products*
- *Tools*
- *Systems and Solutions*

DSP
Product Families Overview


ADI DSP Product Families
Gen 2 SHARC
SHARC
Gen 3 - 16 Bits
Gen 2 - 16 Bits
21xx
Family
S.P. Performance
high
low
low
high
Portability

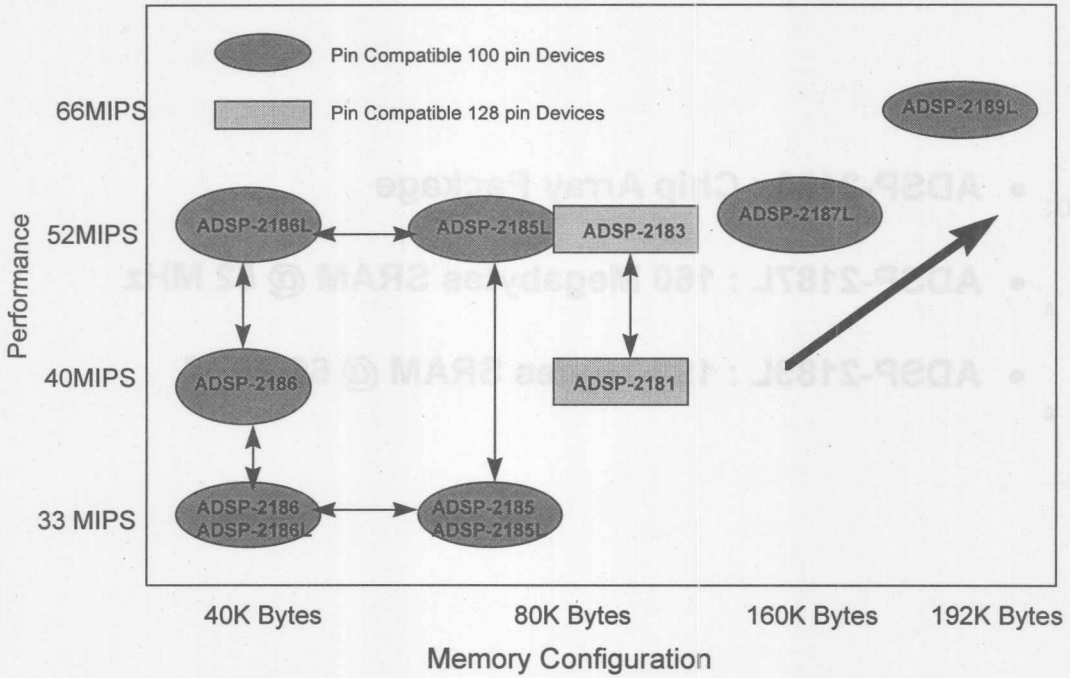


16 Bit DSP Processors

New ADSP-218x Family Members

- **ADSP-2183 : Chip Array Package**
- **ADSP-2187L : 160 Megabytes SRAM @ 52 MHz**
- **ADSP-2189L : 192 kBytes SRAM @ 66 MIPS**

ADSP-218X Family Provides a Pin Compatible Migration Path to 66MHz

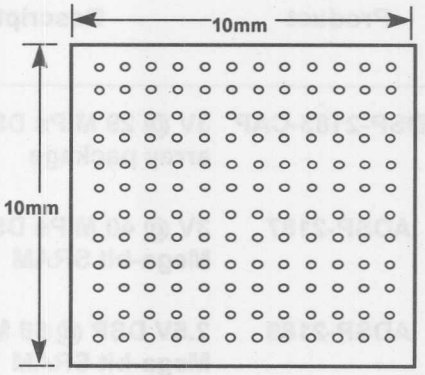


Newest Members of the 218x Family

Product	Description	10K Price	Sampling Date	Prod. Date
ADSP-2183-CAP	3V @ 29 MIPs DSP in Chip array package	$14.54	Now	2Q98
ADSP-2187	3V @ 40 MIPs DSP w/ 1.2 Mega-bit SRAM	$20.80	Now	Now
ADSP-2189	2.5V DSP @ 66 MIPs w/ 1.5 Mega-bit SRAM	$26.30	July	2H98

The ADSP-2183 CAP - The World's Smallest DSP!

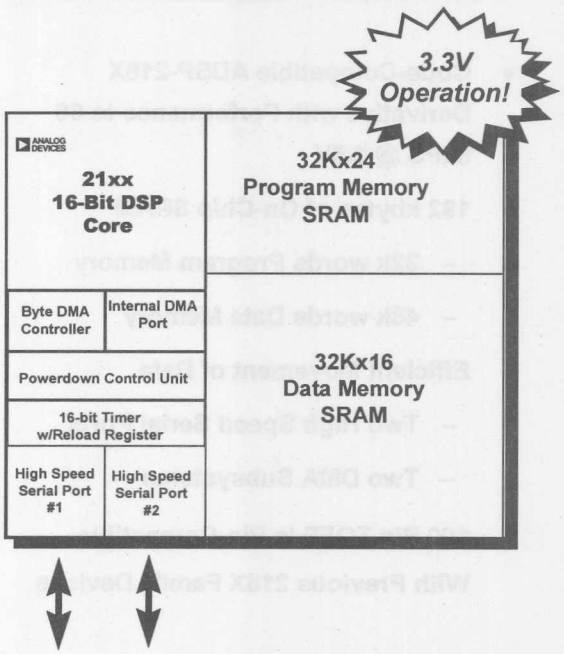
- The Chip Array Package - 52 MIPS in 1cm^2
- Small Size With No Compromises in Performance : 144-Pin Package
- 160Kbytes on-Chip SRAM
- Innovative Packaging for Highly Portable Applications
- Package Size at 0.8 mA Per MIP Targets Handheld Battery-Powered Applications



Chip Array Package
144-ball array

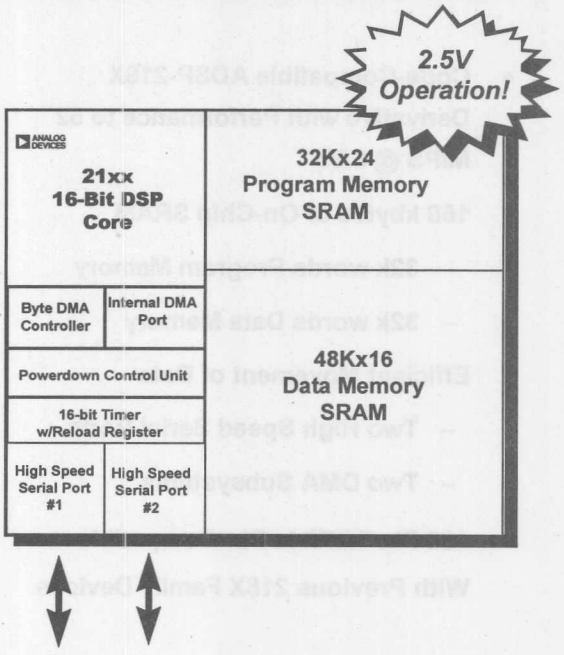
ADSP-2187L - 160Kbytes SRAM @ 52MIPS

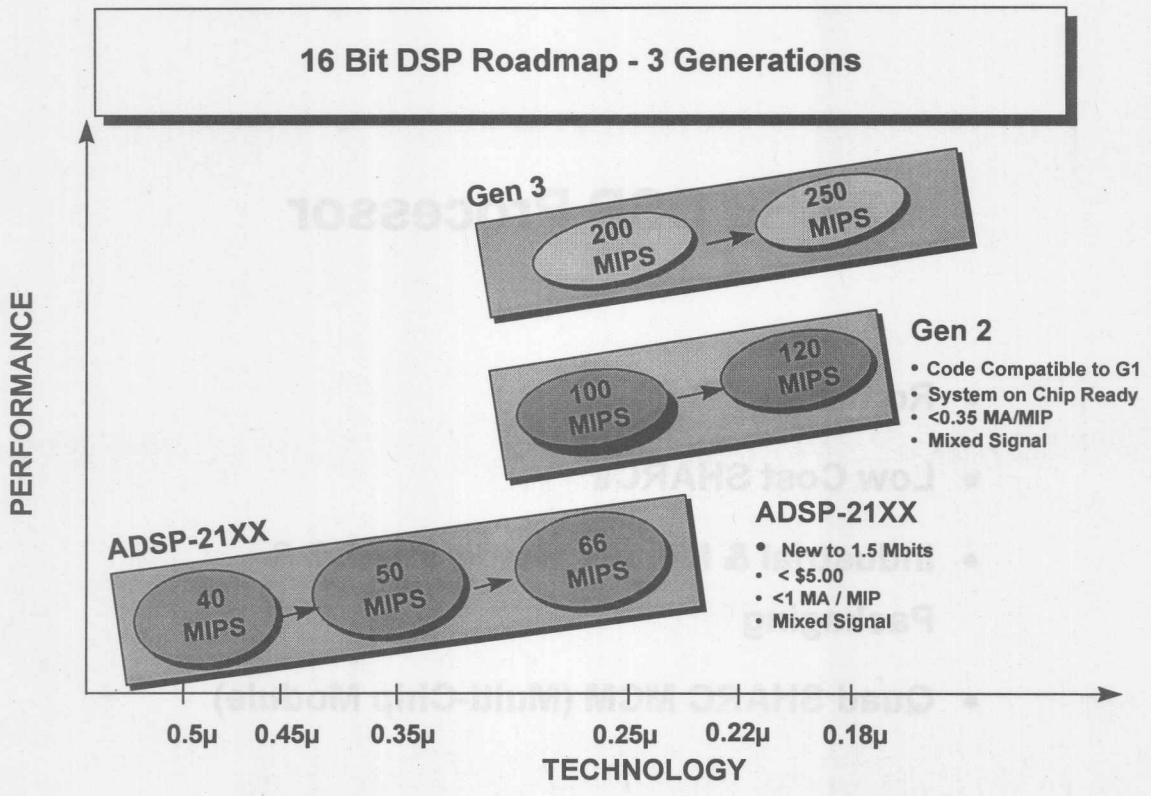
- Code-Compatible ADSP-218X Derivative with Performance to 52 MIPS @ 3.3V
- 160 kbytes of On-Chip SRAM
  - 32k words Program Memory
  - 32k words Data Memory
- Efficient Movement of Data
  - Two High Speed Serial Ports
  - Two DMA Subsystems
- 100 Pin TQFP Is Pin-Compatible With Previous 218X Family Devices

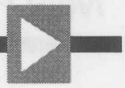


ADSP-2189L - 192Kbytes SRAM @ 52MIPS

- Code-Compatible ADSP-218X Derivative with Performance to 66 MIPS @ 2.5V
- 192 kbytes of On-Chip SRAM
  - 32k words Program Memory
  - 48k words Data Memory
- Efficient Movement of Data
  - Two High Speed Serial Ports
  - Two DMA Subsystems
- 100 Pin TQFP Is Pin-Compatible With Previous 218X Family Devices



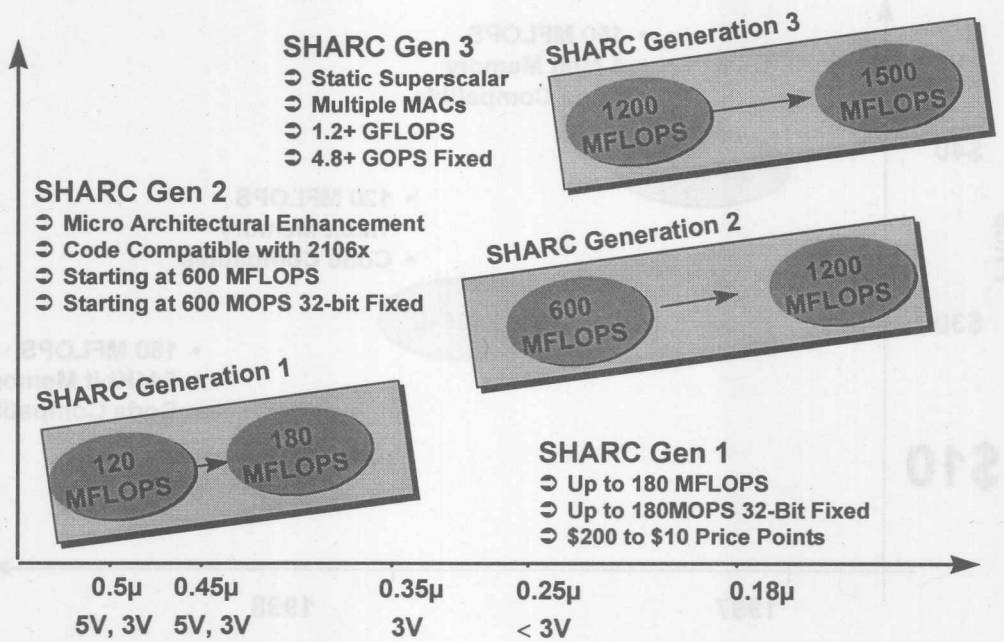

16 Bit DSP Roadmap - 3 Generations
PERFORMANCE
Gen 3
200 MIPS
250 MIPS
Gen 2
100 MIPS
120 MIPS
• Code Compatible to G1
• System on Chip Ready
• <0.35 MA/MIP
• Mixed Signal
ADSP-21XX
40 MIPS
50 MIPS
66 MIPS
ADSP-21XX
• New to 1.5 Mbits
• < $5.00
• <1 MA / MIP
• Mixed Signal
0.5µ
0.45µ
0.35µ
0.25µ
0.22µ
0.18µ
TECHNOLOGY



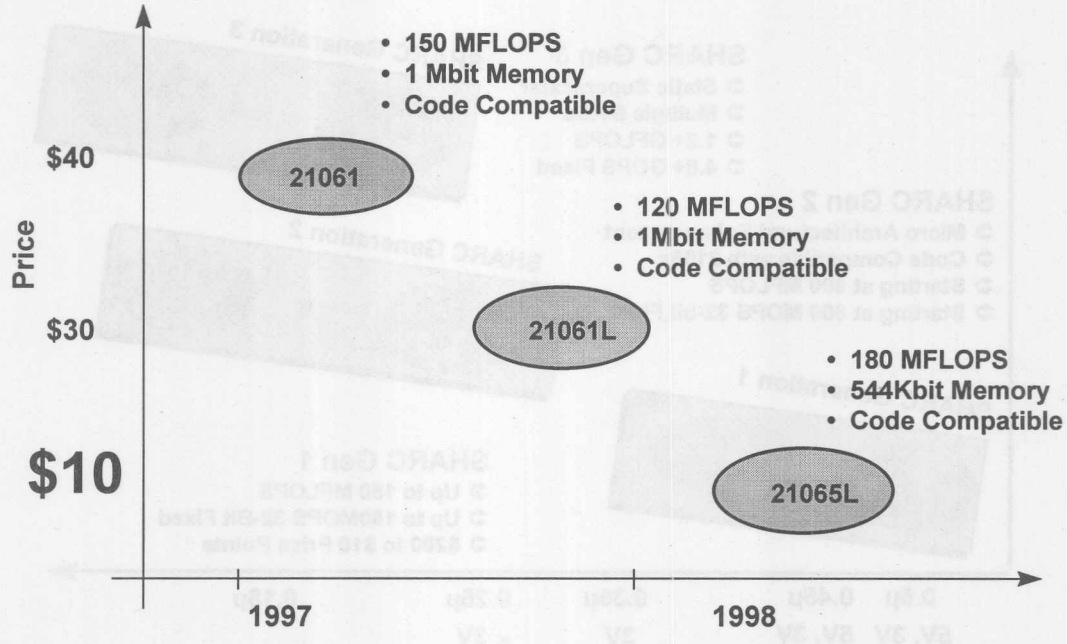
32 Bit DSP Processor

- Roadmap
- Low Cost SHARCs
- Industrial & Military Grade SHARC & Packaging
- Quad SHARC MCM (Multi-Chip Module)

32 Bit Roadmap

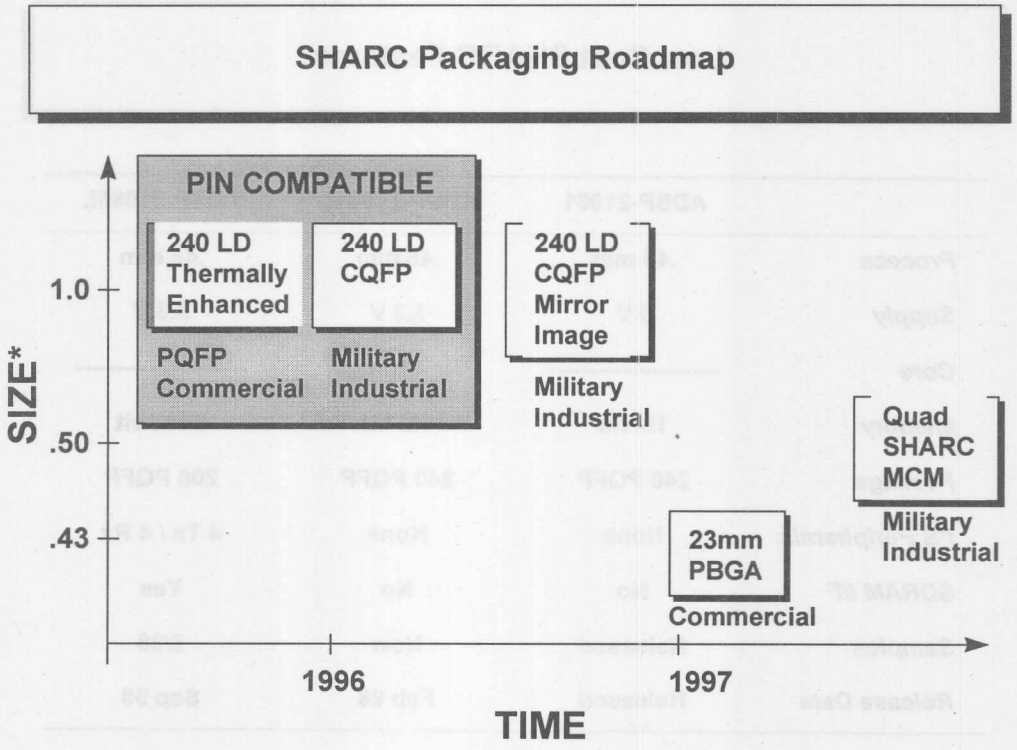


Lowering the Cost of SHARCs



Low Cost SHARC Features

	ADSP-21061	ADSP-21061L	ADSP-21065L
Process	.45 mm	.45 mm	.45 mm
Supply	5 V	3.3 V	3.3 V
Core	----------	No Change	----------
Memory	1M bit	1M bit	544k bit
Package	240 PQFP	240 PQFP	208 PQFP
I^2S Peripherals	None	None	4 Tx / 4 Rx
SDRAM I/F	No	No	Yes
Samples	Released	Now	6/98
Release Date	Released	Feb 98	Sep 98



* Normalized to 240 LD PQFP and one processor

Industrial Temperature and Military SMD SHARCs

- **Industrial Temperature Grade**
  - **Sampling: Now**
  - **Release to production: May 1998**
- **Military SMD**
  - **Release to production June 1998**

Both grades offered in Ceramic QFP, 3.3V or 5V, with either the heat slug up or the heat slug down.

Quad SHARC MCM (Multi-Chip Module)

- Quad 21060 Cluster With Common External Bus
- 40MHz Operation Over Industrial and Mil Temperatures
- 47mm Square Package, .200" Max. Height
- Qualification and Screening to MIL-STD-883

DSP Multiprocessor Products from ADI

The AD14160 and AD14160 are fully integrated, *performance enhanced*, multiprocessor modules targeted at high reliability, performance/density driven applications

AD14060:

- **Quad-21060 module in CQFP**
- **480 MFLOPS**
- **12 link ports, 5 serial ports**

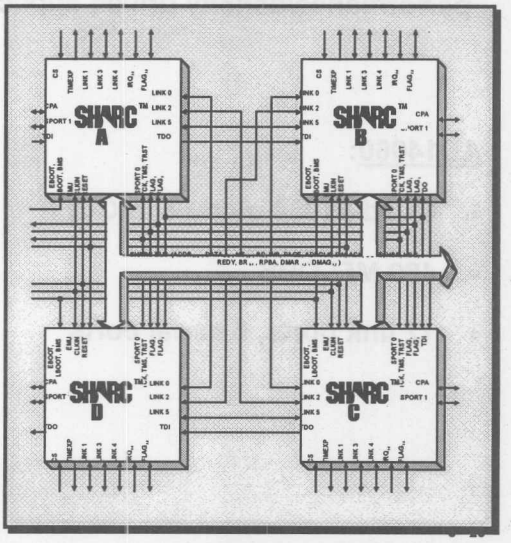
AD14160:

- **Quad-21060 module in CBGA**
- **480 MFLOPS**
- **16 link ports, 8 serial ports**

5 - 19

AD14060
General Purpose MultiProcessor Solution - In Production Now

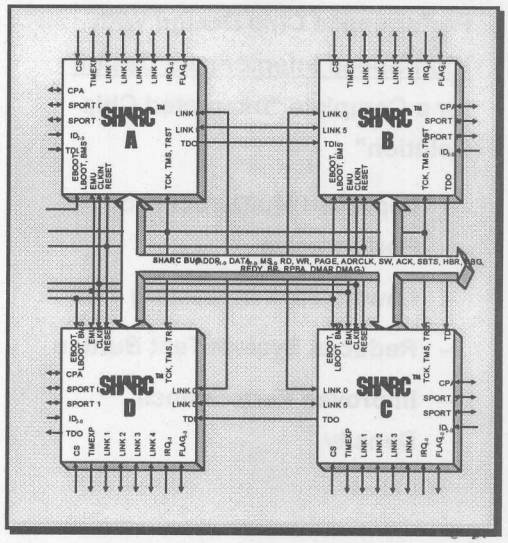
General purpose architecture suitable for shared memory processing and point-to-point communication



- 308 Lead CQFP, Hermetic
- 25 mil Pitch
- 2.05 in sq
- 0.160 in Height

AD14160
General Purpose MultiProcessor Solution - In Production Now

General purpose architecture suitable for shared memory processing and point-to-point communication



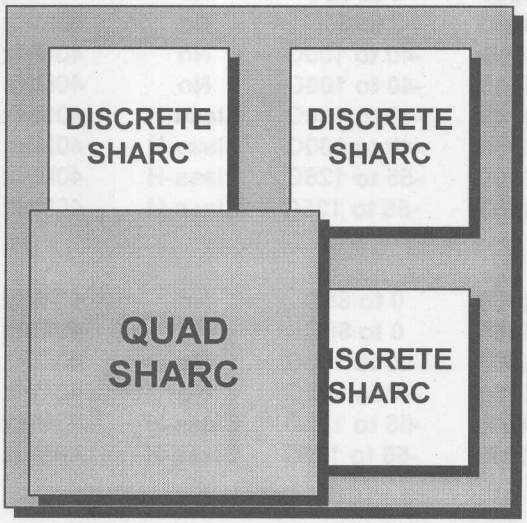
- 452 CBGA, Hermetic
- 1.85 in sq
- 0.200 in Height

AD14060
Electrical Performance Improvements

- AD14060 Combines High-Performance Chip Design With <u>High-Speed Interconnect Design</u> for a Complete "Integrated Chip Solution"
  - Improved Multiprocessor Performance
  - Lowers Risk in Meeting TTM
  - Reduces System Test Burden
  - Improves Performance Density
- Minimized Crosstalk
  - Controlled Impedance
  - Every Trace Interactively Monitored in Routing
  - Parallelism Minimized
- Reduced Ground Bounce
  - Integral GND/PWR Planes
  - Optimized Low-Inductance Wirebonding
- Propagation Delays
  - Minimized in All Cases
  - Clock Traces Minimized and Matched

Board Size Reduction With Single Package DSP Multiprocessors

This shows the density advantage of the QUAD SHARC in comparison to (4) discrete SHARCS using standard board layout



(NOT TO SCALE)

Quad-SHARC® Product Status

Part Number	Processor	Case Temp Range	SMD	Instruction Rate	Oper Voltage	Release Date
CQFP						
AD14060KF-4	21060	0 to 85C	No	40MHz	5V	2Q98
AD14060LKF-4	21060	0 to 85C	No	40MHz	3.3V	2Q98
AD14060BF-4	21060	-40 to 100C	No	40MHz	5V	Released
AD14060LBF-4	21060	-40 to 100C	No	40MHz	3.3V	Released
5962-9750601HXC	21060	-40 to 100C	Class-H	40MHz	5V	Released
5962-9750701HXC	21060	-40 to 100C	Class-H	40MHz	3.3V	Released
5962-9750602HXC	21060	-55 to 125C	Class-H	40MHz	5V	3Q98
5962-9750702HXC	21060	-55 to 125C	Class-H	40MHz	3.3V	3Q98
CBGA						
AD14160KB-4	21060	0 to 85C	No	40MHz	5V	Released
AD14160LKB-4	21060	0 to 85C	No	40MHz	3.3V	Released
AD14160BB-4	21060	-40 to 100C	No	40MHz	5V	2Q98
AD14160LBB-4	21060	-40 to 100C	No	40MHz	3.3V	2Q98
5962-9800302HXA	21060	-55 to 125C	Class-H	40MHz	5V	3Q98
5962-9800402HXA	21060	-55 to 125C	Class-H	40MHz	3.3V	3Q98

5 - 24

Remote Access Server Modems

RAS Modem Software Features

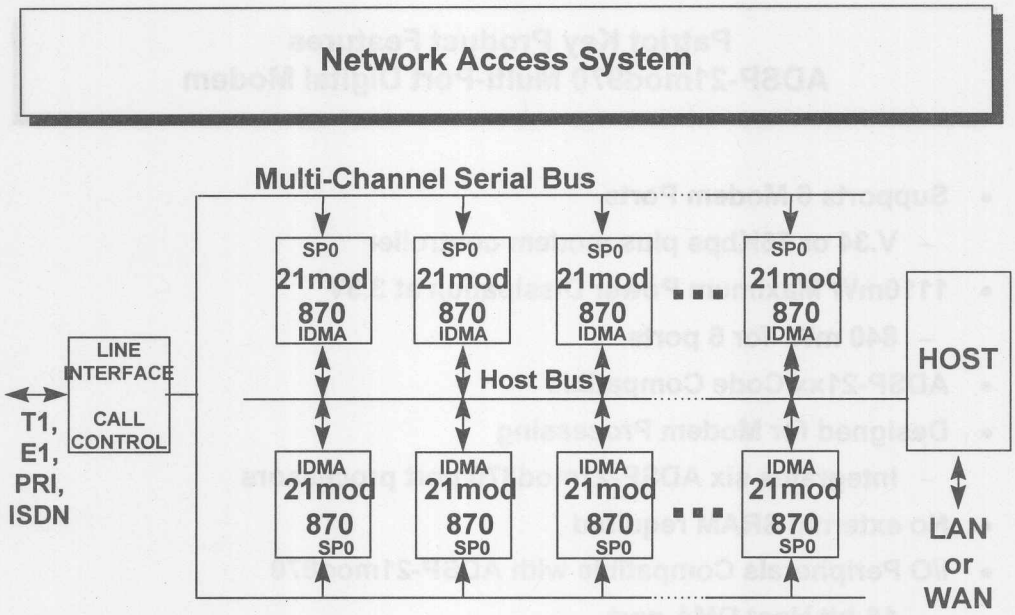
- ISDN B-Channel HDLC
- Data Modulations
  - K56flex (30k-56k)
  - ITU-T V.34: 33600 bits/s - 2400 bits/s
  - CCITT V.32bis: 14400 bits/s - 7200 bits/s
  - CCITT V.32: 9600 bits/s - 4800 bits/s
- Start-up Procedures
  - ITU-T V.8
- CCITT V.42 Error Correction (LAPM & MNP 2-4)
- CCITT V.42bis data & MNP Class 5 Compression
- Software Interface API With Example Code

ADSP-21mod870 Key Features

- Single Chip Modem Implementation
- V.34/56K and V.42/V.42bis controller code.
- 52 MIPS Performance at 3.3V
- 160K Bytes On-Chip SRAM
- 16K x 24 PM plus two 8K x 24 overlay segments
- 16K x 16 DM plus two 8K x 16 overlay segments

ADSP-21mod870 Key Features

- **16-bit DMA Port for host downloads**
- **TDM Serial port supports T1/E1**
- **Powerdown and low-power idle modes**
- **100 lead TQFP package -- .4 square inch footprint**
- **Maximum Power = 140mW at 3.3V and 40MIPS**
- **Fully ADSP-21xx Code Compatible**



ADSP-21mod870 Functions

V.34 Modem	DTMF Dialing
56K Modem	PPP Framing
V.17 FAX	HDLC protocol
V.42, V.42bis, MNP2-5	

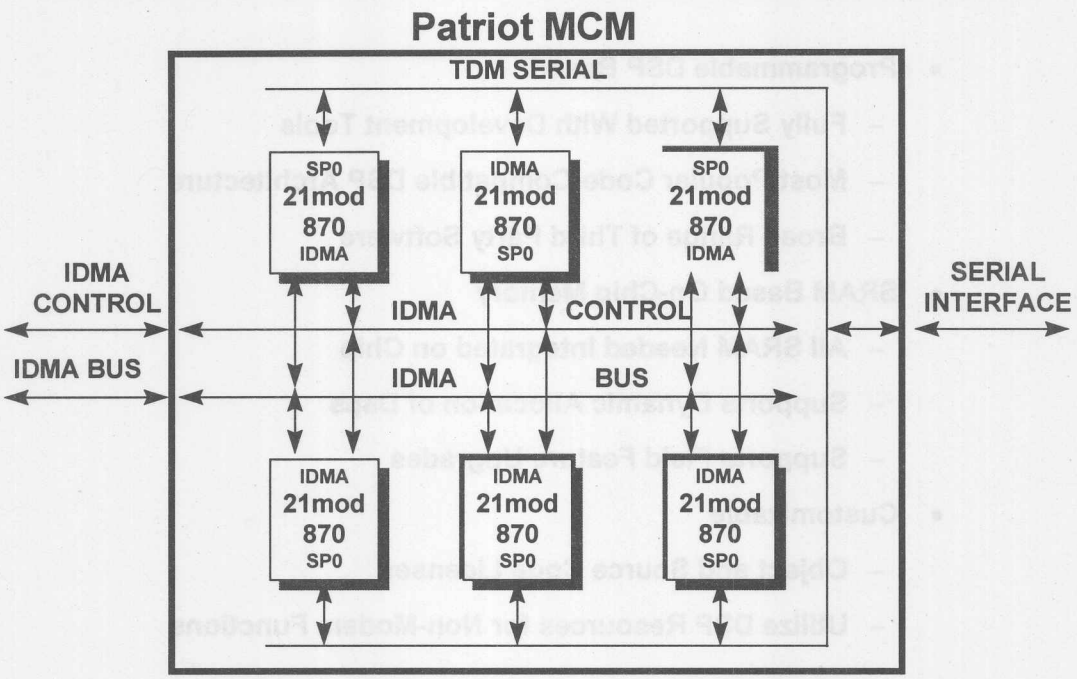
Host Functions

Multi-DSP Control, Data and Overlay Management

Patriot Key Product Features
ADSP-21mod970 Multi-Port Digital Modem

- Supports 6 Modem Ports
  - V.34 or 56Kbps plus modem controller
- 1110mW Maximum Power Dissipation at 3.3V
  - 840 mW for 6 ports
- ADSP-21xx Code Compatible
- Designed for Modem Processing
  - Integrates six ADSP-21mod870 port processors
- No external SRAM required
- I/O Peripherals Compatible with ADSP-21mod870
  - 16-bit Host DMA port
  - TDM Serial port
- 304 ball PBGA (31mm x 31mm x 2.3mm)
  - 1.45 sq. in foot print

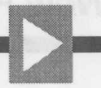
Patriot Configuration



ADI Open Architecture

- Programmable DSP Based
  - Fully Supported With Development Tools
  - Most Popular Code-Compatible DSP Architecture
  - Broad Range of Third Party Software
- SRAM Based On-Chip Memory
  - All SRAM Needed Integrated on Chip
  - Supports Dynamic Allocation of Dsps
  - Supports Field Feature Upgrades
- Customizable
  - Object and Source Code Licenses
  - Utilize DSP Resources for Non-Modem Functions

DSP Tools



Visual DSP: A Common Platform for DSP Development

- Visual DSP Will Be a Common Platform for Development Across All Analog Devices DSP Families.
- Visual DSP 2.0 Contains, -
  - Debugger Front-End
  - Integrated Development Environment
- Visual DSP Will First Support the SHARC Family, and Will Be Bundled With the Next Release of SHARC Tools, 4.0.

What is an Integrated Design Environment?

- One Windows Application That Controls All the Functions Needed to Generate Code.
  - File Editing
  - Tool, File and Build Management
  - Control of Assembler, Compiler, Linker, Loader and Splitter
  - Help and Error Indexing
- Common Environment and Published Apis Enable Third Party Tools to Operate in Visual DSP IDE.

Visual DSP 2.0 / SHARC 4.0 Release

- VisualDSP Debugger & Integrated Development Environment
- Supports ADSP-21060, -21061, -21062, and *new -21065L*
- Operates on Windows NT and Windows 95
- *New* C Compiler
- *New* Linker Technology
- On-line Documentation
- Scheduled Release Date: June 1998

New SHARC C Compiler (Included in VDSP 2.0/SHARC 4.0)

- New Optimizing C Compiler for 2106X
  - Not GNU based
  - Edison Design Group/Kuck and Assoc. Front End
  - Edinburgh Portable Compilers code generator
- Extensions to ANSI C
  - dm/pm, inline assembly, numerical, complex
- Integrated into IDE

16 Bit Family Software Tools Release 6.0

- Scheduled Release Date: April 1998
- 2100 Family Software Tools Release 6.0 Includes
  - VisualDSP Debugger for Simulator
  - New Linker with Overlay Support
  - Bug Fixes on Assembler, Compiler, Loader, Splitter
- Supports Windows 95 and Windows NT

ADSP-218x EZ-ICE Software Release 2.0

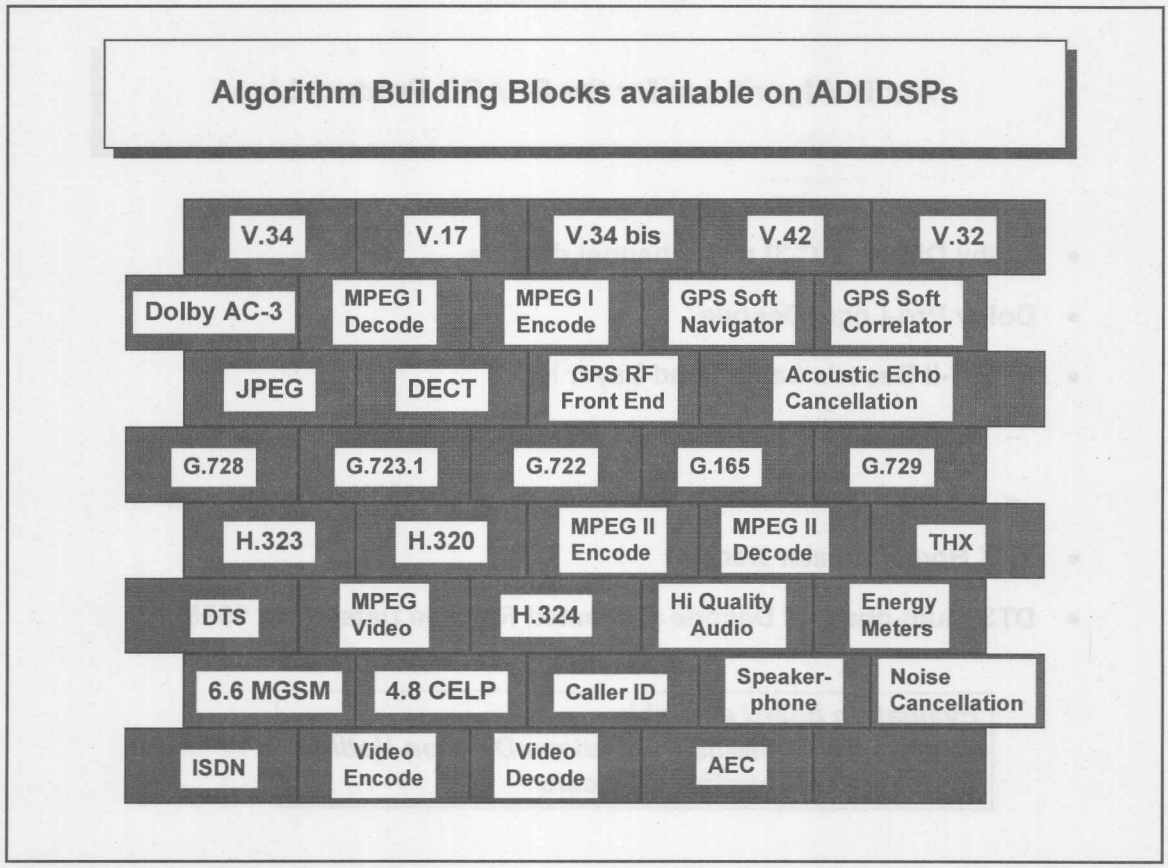
- Expected Release Date: March 1998
- Full-Speed Incircuit Emulation of *ALL* ADSP-218x Processors
- Non-Intrusive Debug Facility
- Supports all 218x Boot Modes
- Supports Windows NT, Windows 95, Windows 3.1
- Enhanced C debugging, breakpoint capabilities, and overlay memory support

Systems and Solutions from Analog Devices

Systems and Solutions From Analog Devices

ADI's Software & Systems Technologies Division is dedicated to providing the building blocks for OEM Solutions

- Algorithm Chipsets Available Using ADI Silicon Products and Globally Sourced Software Object Code Modules
- Reference Designs Available, Including Orcad Files, Documentation, Software, Bill of Materials
- "Black Box" Type Modules for Fast Time to Market in Engineering Challenged Environments:
  - Digital Telephony (Low End and High End Featurephones)
  - High Quality Audio (Dolby Digital, DTS, THX, MPEG)
- Flexible Engineering Business Models Designed to Add Value and Add Expertise to OEM Engineering Challenges


Algorithm Building Blocks available on ADI DSPs
V.34
V.17
V.34 bis
V.42
V.32
Dolby AC-3
MPEG I Decode
MPEG I Encode
GPS Soft Navigator
GPS Soft Correlator
JPEG
DECT
GPS RF Front End
Acoustic Echo Cancellation
G.728
G.723.1
G.722
G.165
G.729
H.323
H.320
MPEG II Encode
MPEG II Decode
THX
DTS
MPEG Video
H.324
Hi Quality Audio
Energy Meters
6.6 MGSM
4.8 CELP
Caller ID
Speaker-phone
Noise Cancellation
ISDN
Video Encode
Video Decode
AEC

Audio Algorithms for the SHARC Product Line

- Dolby Digital (AC-3) multichannel decode
- Dolby Pro-Logic Decode
- MPEG-II Decode Layer I and Layer II
  - complies with ISO/IEC 13818-3 audio standard
  - MPEG Audio I / II also available on ADSP-218X product
- THX Home Theater Decode
- DTS Multi-channel Decode (Expected Release Date: May 1998)

Evaluation board available,
contact ADI Systems & Solutions Division Hotline:
systems.solutions@analog.com

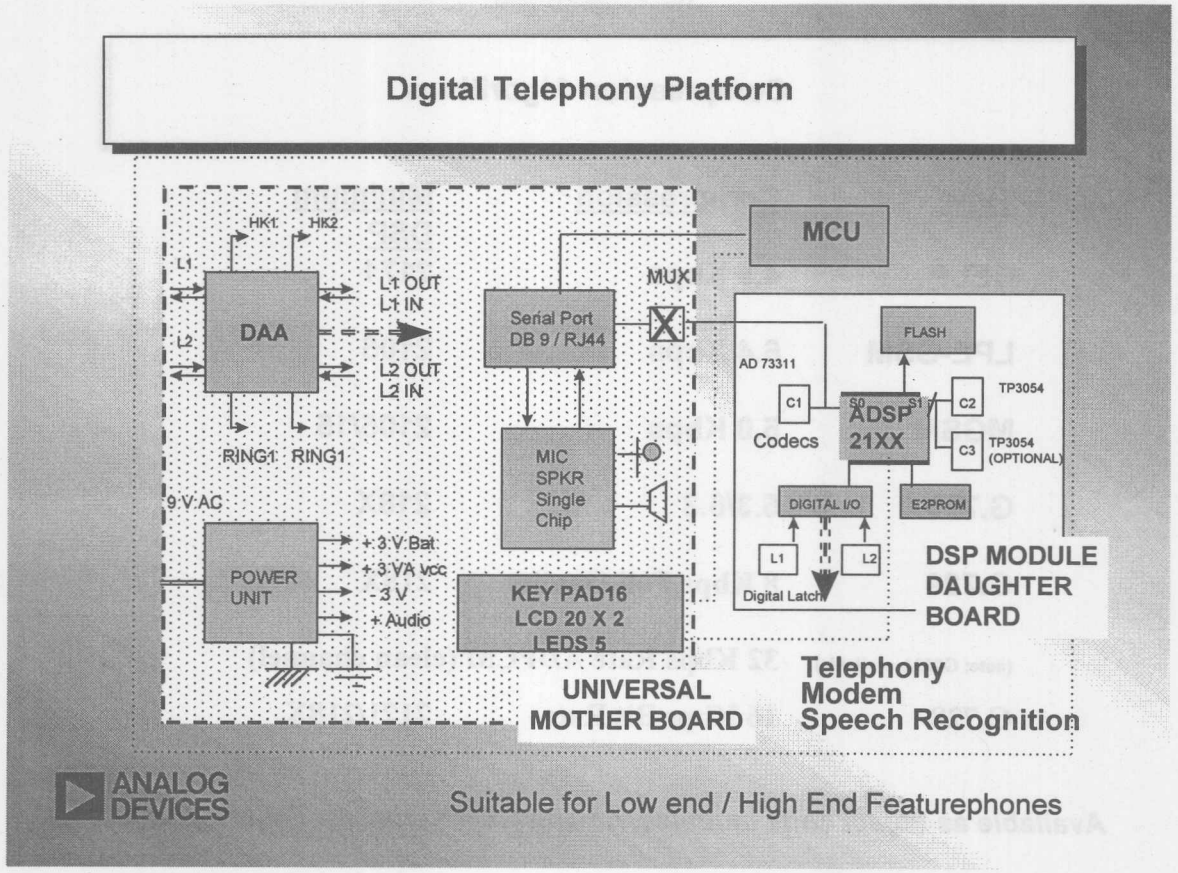
Telephony Algorithms

- Acoustic Echo Cancellation
- Tone generation, DTMF
- DTMF receiver
- Call Progress Tone detection
- Caller ID
- Caller ID on Call Waiting
- AGC
- Voice Activity Detector
- Fax CNG Detection
- MGSM Speech Compression (note, that other speech compression algorithms are also available, such as CELP and G.723)
- V.34 Fax Modem (56K in development)

Available as object code modules, or with DSP Kernel for Featurephone

Telephony/Modem Algorithms

- **Full Duplex Speakerphone**
  - **Includes Caller ID Type I and II, DTMF and Call Progress**
  - **AEC (G.167), LEC (G.165), And Automatic Gain Control**
- **Digital Answering Machine**
  - **5.0Kbps Modified GSM Speech Compression for 15 Minutes of Stored Voice**
- **V.34 Modem (56K Available Summer 1998)**


Digital Telephony Platform
HK1
HK2
L1
L2
DAA
L1 OUT
L1 IN
L2 OUT
L2 IN
RING1
RING1
9 V AC
POWER UNIT
+ 3 V Bat
+ 3 VA vcc
3 V
+ Audio
Serial Port DB 9 / RJ44
MUX
MIC SPKR Single Chip
KEY PAD16 LCD 20 X 2 LEDS 5
MCU
UNIVERSAL MOTHER BOARD
AD 73311
Codecs
FLASH
ADSP 21XX
S0
S1
C1
C2
C3
TP3054
TP3054 (OPTIONAL)
DIGITAL I/O
E2PROM
L1
L2
Digital Latch
DSP MODULE DAUGHTER BOARD
Telephony
Modem
Speech Recognition
ANALOG DEVICES
Suitable for Low end / High End Featurephones

Compression Algorithms

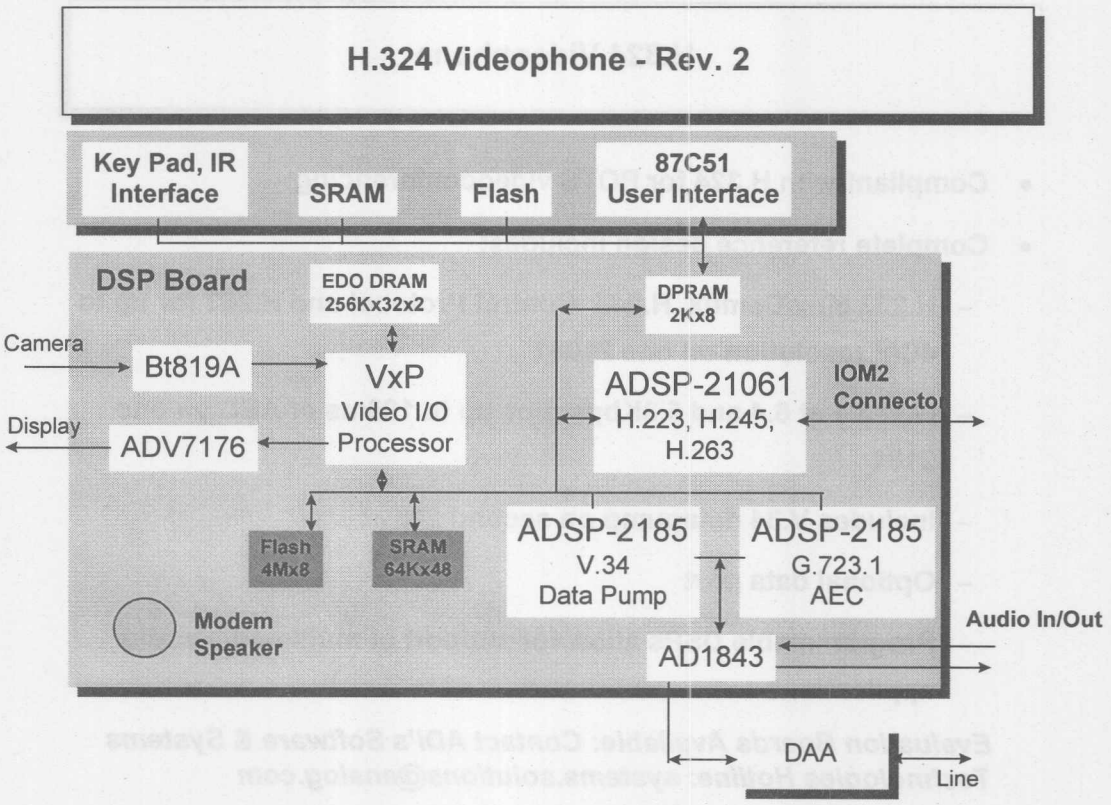
Type	Compression	Minimum DSP
CELP	4.8 Kbps	2171
LPE-GSM	6.4 Kbps	2105
MGSM	5.0 Kbps	2105/15
G.723.1	5.3/6.3	218X
G.729	8 Kbps Toll Quality	218X
(note: G729A available)	32 Kbps Rate ADPCM (clean channel)	
G.728	16 Kbps Bit Rate	2171/218X

Available as object code modules, or with DSP Kernel for Featurephone

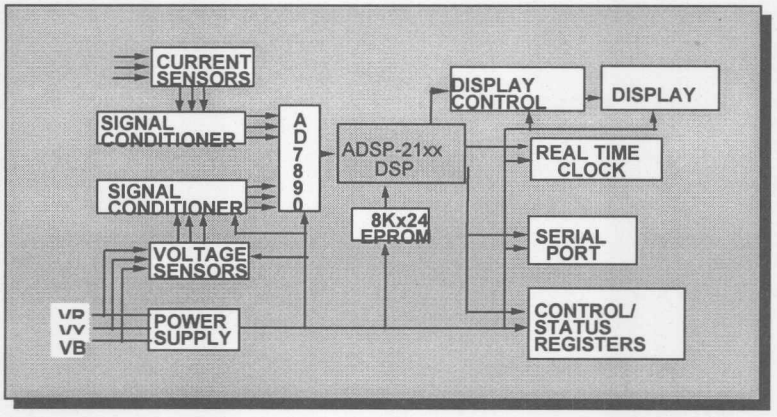
H.324 Videophone

- Compliant with H.324 for POTS videoconferencing
- Complete reference design includes:
  - H.223 Mux/Demux, H.245 Control Protocol and H.263 for up to 4CIF resolution on one 21061
  - G.723.1 at 6.4 and 5.3Kbps plus up to 100ms of AEC on one 2181
  - Includes V.34 datapump on second 2181
  - Optional data port
  - Programmable DSPs allow for support of multimedia audio applications

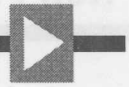
Evaluation Boards Available: Contact ADI's Software & Systems Technologies Hotline: systems.solutions@analog.com


H.324 Videophone - Rev. 2
Key Pad, IR Interface
SRAM
Flash
87C51 User Interface
DSP Board
EDO DRAM 256Kx32x2
DPRAM 2Kx8
Camera
Bt819A
VxP Video I/O Processor
ADSP-21061 H.223, H.245, H.263
IOM2 Connecto
Display
ADV7176
Flash 4Mx8
SRAM 64Kx48
ADSP-2185 V.34 Data Pump
ADSP-2185 G.723.1 AEC
Modem Speaker
Audio In/Out
AD1843
DAA
Line

Salem 3-Phase Energy Meter



- 3-Phase, 3-Wire/4-Wire Supply
- 0.5% Accuracy
- Multiple Programmable Measurements



SECTION 6
DATA CONVERTER SUPPORT COMPONENTS

Low Power, Low Drop Out Voltage References

High Speed, Buffered Video Muxes

High Speed Crosspoint Switches

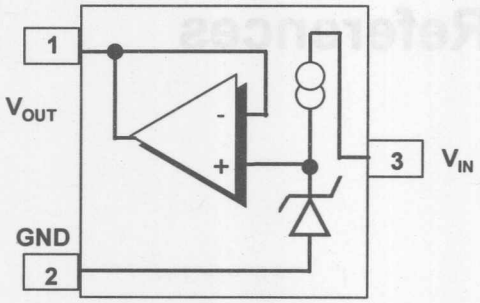
CMOS Switches and Multiplexers

Input Channel Overvoltage Protectors

Voltage References

AD1581-AD1585
1.2V to 5.0V Micropower, Precision Voltage References

The AD1581 - AD1585 are a family of *low cost*, low power, low dropout, three terminal precision bandgap voltage references in a compact, SOT-23 surface-mount package.



AD1581-1585

Model	V_{out}
AD1581*	1.200 V
AD1582	2.500 V
AD1583	3.000 V
AD1584	4.500 V
AD1585	5.000 V

AD1581-AD1585 : Key Specs and Features

- **High Accuracy: ± 0.8 % max**
- **Output Voltage Drift: 25 ppm/deg C max**
- **Wide Operating Range: $V_{in} = V_{out}$ + (200 mV to 12V)**
- **Sink or Source up to 10 mA Current**
- **Load Regulation: 10 mV max, 50 uA ≤ I_{in} ≤ 10 mA**
- **Output Impedance < 1 ohm**
- **Wideband Noise typ 50 uV rms, 10 Hz - 10 kHz**
- **-40 deg C to +85 deg C Operating Temperature Range**
- **Compact, Surface-Mount, SOT-23 Package**

6-5

The ADR2X Series... A Revolutionary New Family of Precision, Micropower Voltage References That Employ a Unique XFET™ Architecture to Achieve Very Low Noise and Very Low Power Consumption!

ADR290, ADR291 ADR292 and AD2R93
Micropower Precision References

- 2.048V, 2.500V, 4.096V and 5.000V
- 2.7V to 15V Supply Range
- Supply Current only 12 uA max!
- Initial Accuracy : ± 2 mV max
- Tempco : 5 ppm/deg C max
- Long Term Drift : 0.2 ppm/1,000 hours
- Low Noise : 10 uV p-p
- Wideband Noise : 95 nV/ root Hz @ I kHz
- High Output Current : 5 mA min
- Temperature Range : -40 deg C to +125 deg C
- REF02 and REF19X Pinout
- 8 Pin SOIC and TSSOP and 3 lead TO-92 Packages

ADR2X Family

- **XFET Design Offes Lower Noise Than Conventional Bandgap References**
- **ADR2XX Operating at 12 uA Exhibit the Same Noise As Bandgaps Operating at > 100 uA**
- **Wide Operating Temperature Range (-40 deg C to +125 deg C) Makes the ADR2X Suitable for Use in Automotive, Communications and Instrumentation Applications**
- **Standard Ref-02 and Ref19X Pinout Allows for Future Upgrade**

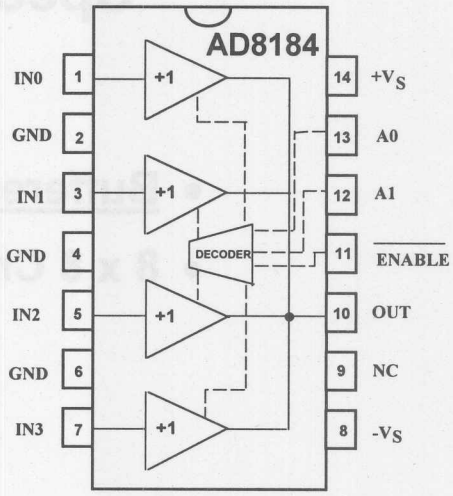
A New Family of Unique Video Speed Products...

- Buffered Multiplexers !
- 8 x 8 Crosspoint Switches !

AD8184
4:1, 700MHz Video Multiplexer

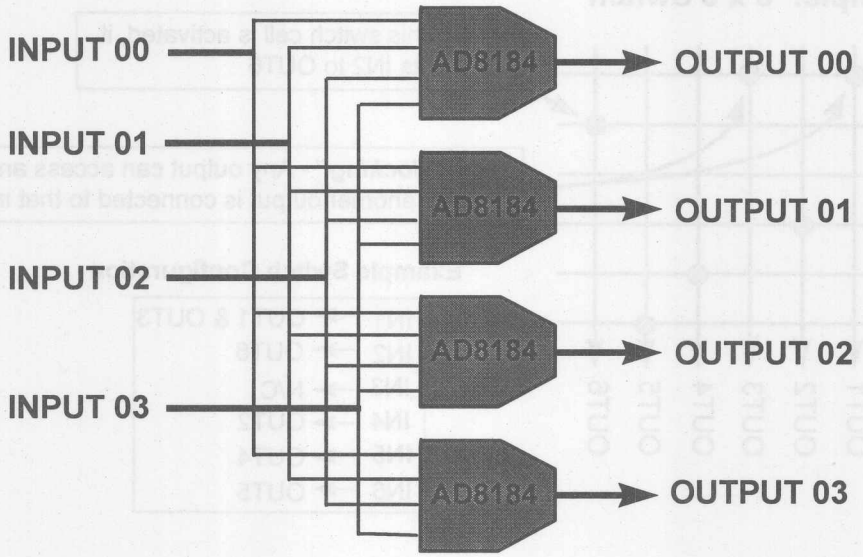
The AD8184 is a 4:1 version of our popular AD8180

- **Fully Buffered Inputs & Outputs**
- **High Speed : 700MHz (-3dB)**
- **750V/ms Slew Rate**
- **85 MHz 0.1dB Flatness**
- **0.01%/0.01° Differential Gain/Phase**
- **Low Power: 4.4mA**



6 - 10

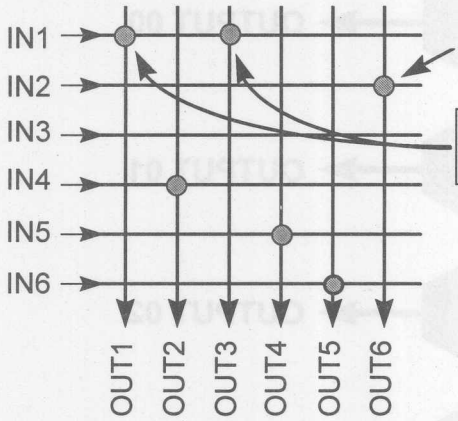
Application Example: 4 x 4 Crosspoint Switch



6 - 11

What's a Crosspoint Switch?

Example: 6 x 6 Switch



When this switch cell is activated, it connects IN2 to OUT6

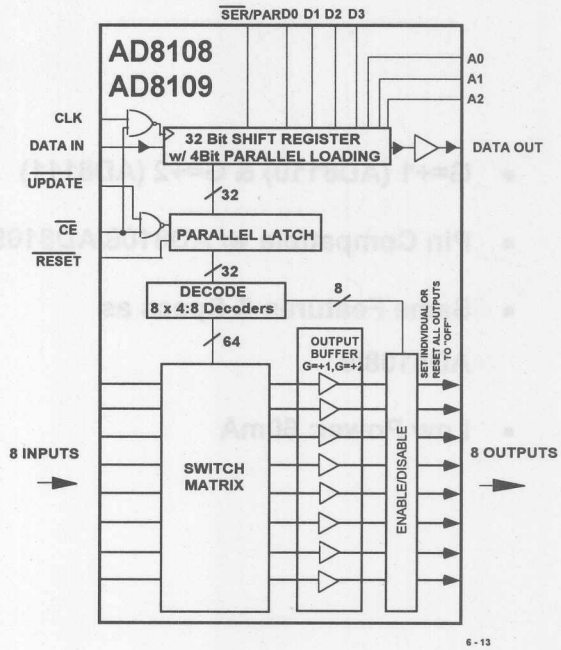
"Non-Blocking" - Any output can access any input. (Even if another output is connected to that input)

Example Switch Configuration

IN1 →	OUT1 & OUT3
IN2 →	OUT6
IN3 →	N/C
IN4 →	OUT2
IN5 →	OUT4
IN6 →	OUT5

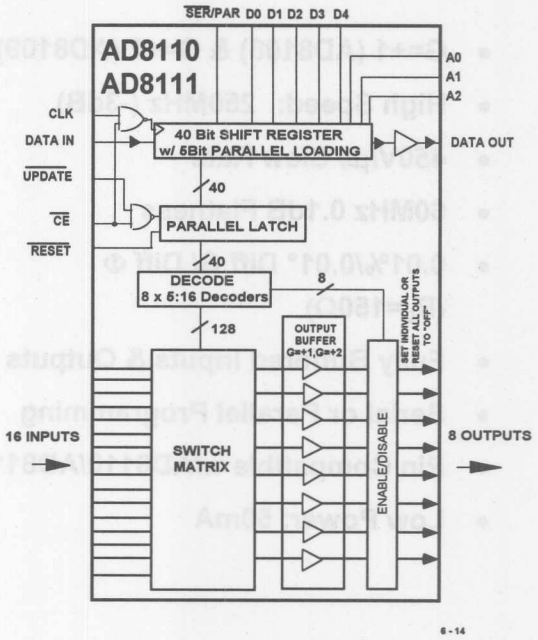
AD8108 and AD8109
8 x 8 Video Crosspoints

- G=+1 (AD8108) & G=+2 (AD8109)
- High Speed: 250MHz (-3dB)
- 450V/μs Slew Rate
- 60MHz 0.1dB Flatness
- 0.01%/0.01° Diff G/ Diff Φ (R_L=150Ω)
- Fully Buffered Inputs & Outputs
- Serial or Parallel Programming
- Pin Compatible w/AD8110/AD8111
- Low Power: 50mA

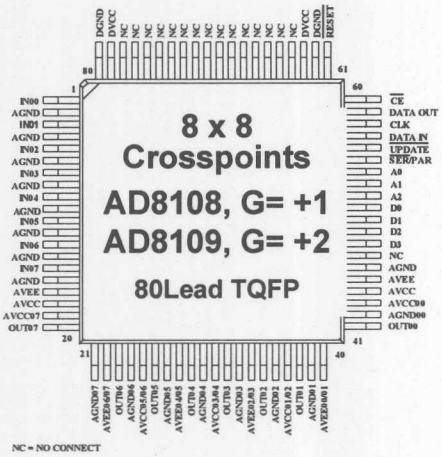


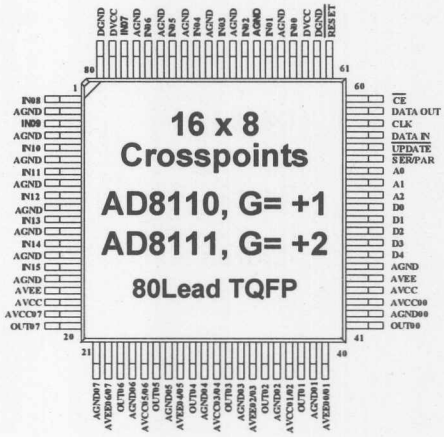
AD8110 and AD8111
16 x 8 Video Crosspoint Switches

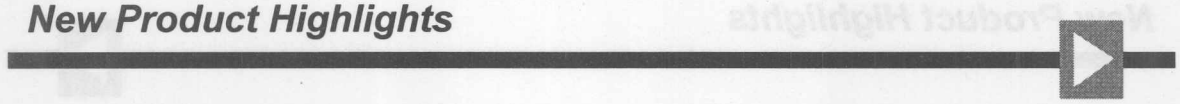
- G=+1 (AD8110) & G=+2 (AD8111)
- Pin Compatible w/ AD8108/AD8109
- Same Features & Specs as AD8108/9
- Low Power: 60mA



Pin Compatible 8x8 & 16x8 Crosspoints... Creating the New Industry Standard

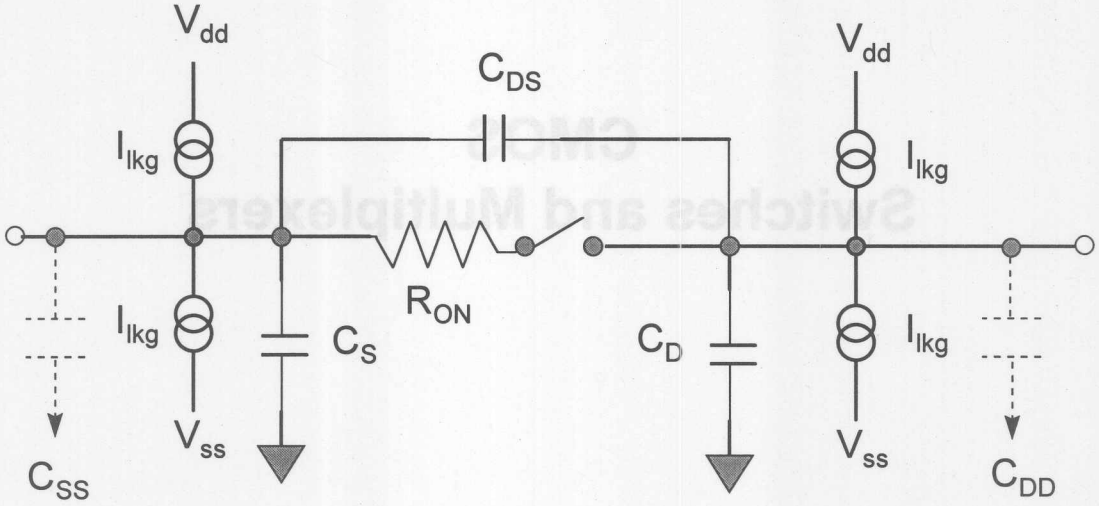






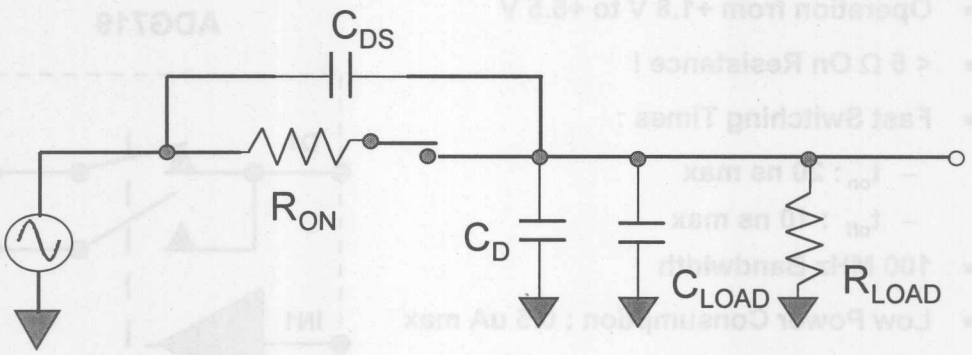
CMOS
Switches and Multiplexers

Important CMOS Switch Parameters...



6-18

Bandwidth Analysis



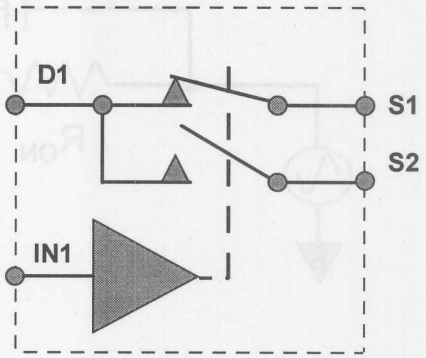
$$F_C = \frac{1}{(2\pi RC)} \qquad R = \frac{R_L \times R_{ON}}{R_L + R_{ON}} \qquad C = C_D + C_L$$

6 - 19

ADG719, ADG736
Single, Dual CMOS SPDT Switches

- Operation from +1.8 V to +5.5 V
- < 5 Ω On Resistance !
- Fast Switching Times :
  - t_{on} : 20 ns max
  - t_{off} : 10 ns max
- 100 MHz Bandwidth
- Low Power Consumption : 0.5 uA max
- TTL/CMOS Compatible
- 6 Lead SOT-23 and 8-lead µSOIC Packages (ADG719)
- 10 Lead µSOIC Package (ADG736)

ADG719

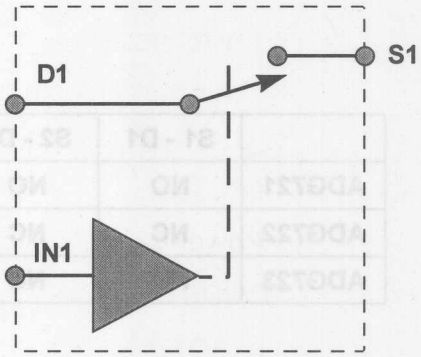


Switches Shown for Logic "1" Input

6 - 20

ADG701 and ADG702
Low R_{ON} Precision CMOS SPST Switches

- Operation from +1.8 V to +5.5 V
- 1 Ω Typical On Resistance !
- R_{ON} Flatness vs Vs : 1 Ω max
- Fast Switching Times
  - t_{on} : 20 ns max
  - t_{off} : 10 ns max
- 100 MHz Bandwidth
- Low Power Consumption : 0.5 uA max
- Low Charge Injection : 10 pC typ
- TTL/CMOS Compatible
- 6 Lead SOT-23 and 8-lead µSOIC Packages



ADG701 : Normally Closed
ADG702 : Normally Open

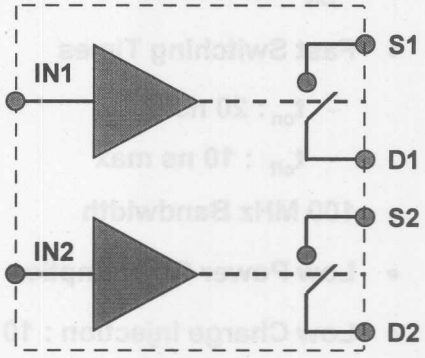
6 - 21

ADG721, ADG722 and ADG723
Dual CMOS SPST Switches

Dual Versions of the ADG701, ADG702

	S1 - D1	S2 - D2
ADG721	NO	NO
ADG722	NC	NC
ADG723	NO	NC

Switches Shown for a Logic "0" Input



8 Lead μSOIC Package

6-22

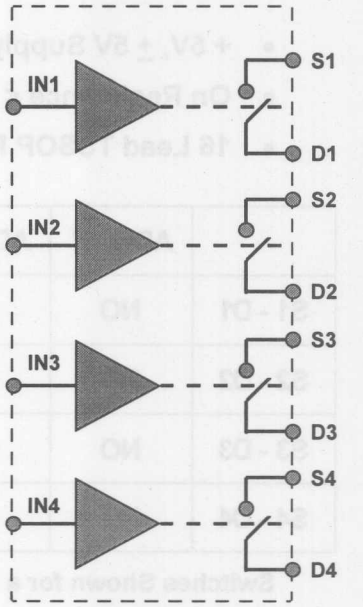
ADG711, ADG712 and ADG713
Quad CMOS SPST Switches

Quad Versions of the ADG701, ADG702

	ADG711	ADG712	ADG713
S1 - D1	NO	NC	NC
S2 - D2	NO	NC	NO
S3 - D3	NO	NC	NO
S4 - D4	NO	NC	NC

Switches Shown for a Logic "1" Input

16 Lead TSSOP Package



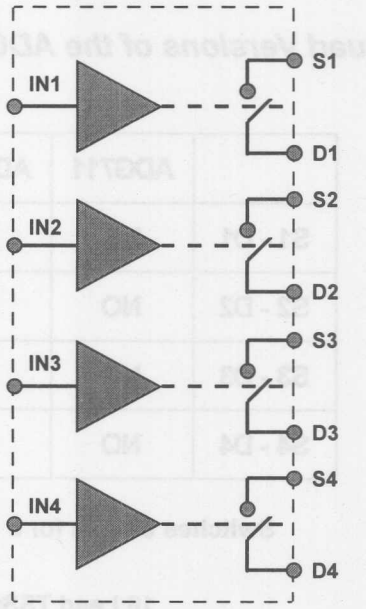
6 - 23

ADG661, ADG662, ADG663
Quad SPST Switches

- + 5V, ± 5V Supply Operation
- On Resistance < 50 Ω
- 16 Lead TSSOP Package

	ADG661	ADG662	ADG663
S1 - D1	NO	NC	NO
S2 - D2	NO	NC	NO
S3 - D3	NO	NC	NC
S4 - D4	NO	NC	NC

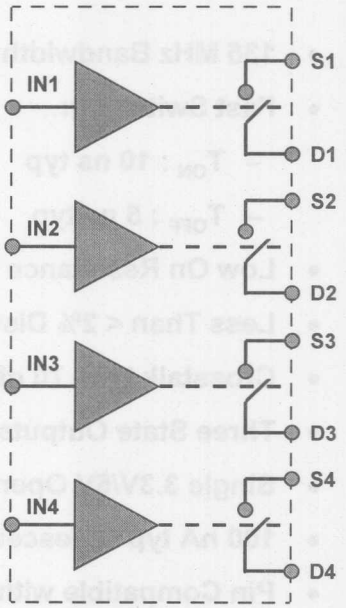
Switches Shown for a Logic "0" Input



6 - 24

ADG451, ADG452 and ADG453
Quad CMOS SPST Switches

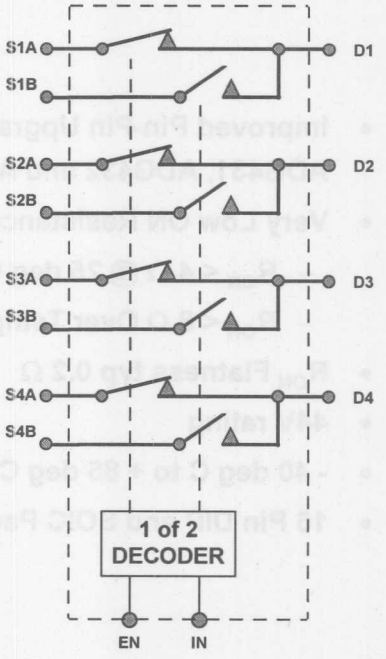
- Improved Pin-Pin Upgrade to ADI's ADG431, ADG432 and ADG433
- Very Low ON Resistance:
  - R_{ON} < 4 Ω @ 25 deg C
  - R_{ON} < 8 Ω Over Temp
- R_{ON} Flatness typ 0.2 Ω
- 44V rating
- - 40 deg C to + 85 deg C
- 16 Pin DIP and SOIC Packages

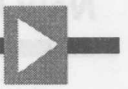


6 - 25

ADG774
Quad 2:1 Multiplexer

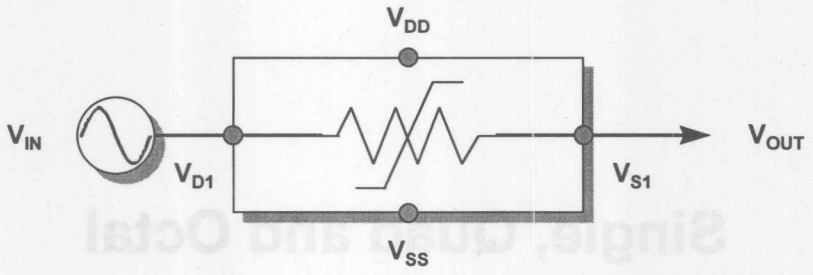
- 135 MHz Bandwidth
- Fast Switching:
  - T_{ON} : 10 ns typ
  - T_{OFF} : 5 ns typ
- Low On Resistance : 6 Ω typ
- Less Than < 2% Distortion
- Crosstalk typ - 70 dB @ 30 MHz
- Three State Outputs
- Single 3.3V/5V Operation
- 100 nA typ Quiescent Current
- Pin Compatible with P15L200





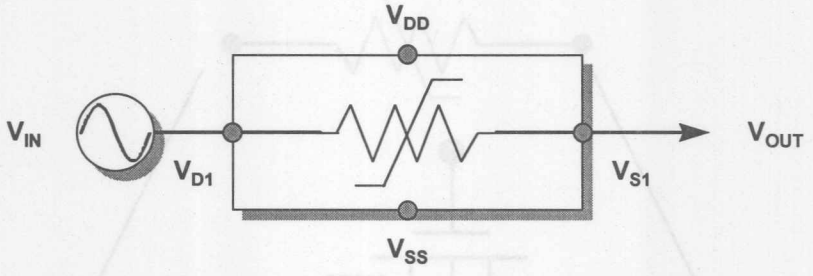
Single, Quad and Octal Channel Input Protectors

What Are Channel Protectors?



- **Channel Protector Behaves Like a Series Resistor During Normal Operation.**
- **Positive Overvoltages Are Clamped at V_{DD} - 1.5V**
- **Negative Overvoltages Are Clamped at V_{SS} + 2V**
- **With $V_{DD} = V_{SS} = 0V$ the Channel Protectors Are Open Circuit and Currents Are Limited to Sub µA Levels**

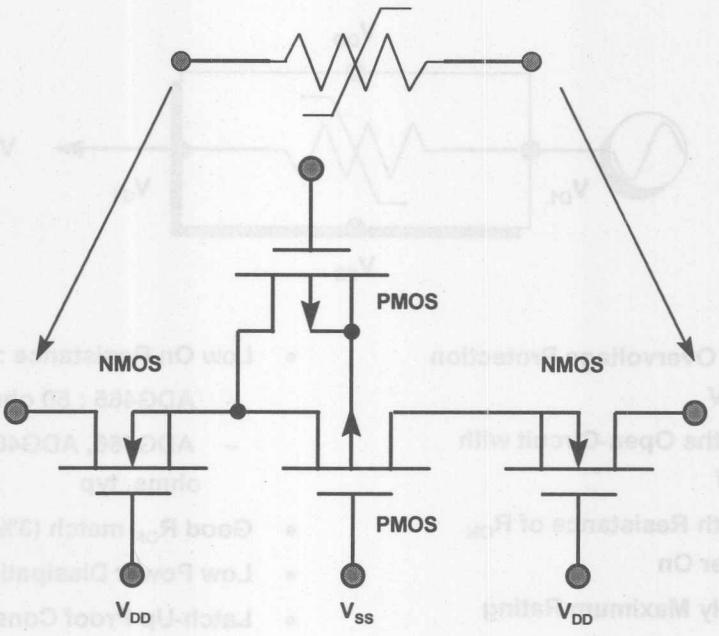
ADG465, ADG466 and ADG467
Single, Triple and Octal Channel Protectors



- Fault and Overvoltage Protection up to ±35V
- Signal Paths Open-Circuit with Power Off
- Signal Path Resistance of R_{ON} with Power On
- 44V Supply Maximum Rating
- Low On Resistance :
  - ADG465 : 50 ohms, typ
  - ADG466, ADG467 : 100 ohms, typ
- Good R_{ON} match (3% max)
- Low Power Dissipation (3.3mW)
- Latch-Up Proof Construction

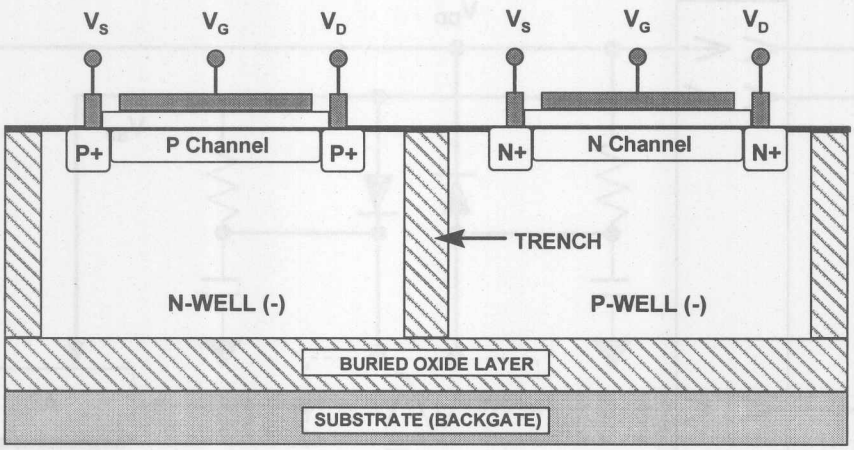
6 - 29

ADG46X Series Channel Protectors - Simplified Schematic



6 - 30

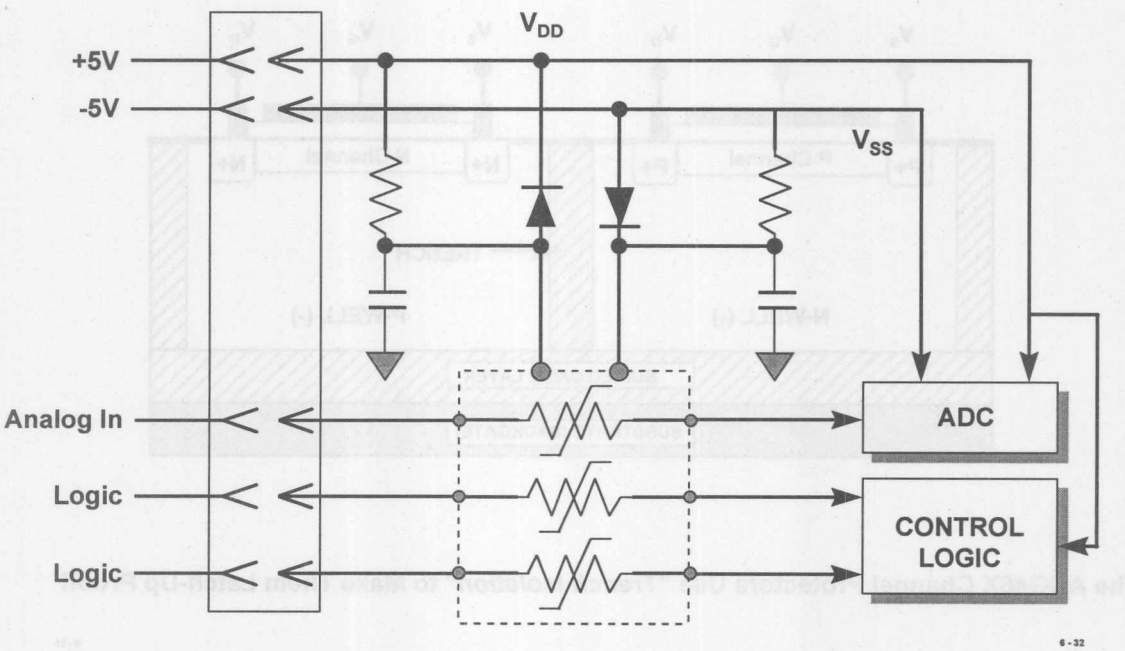
Trench Isolation

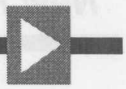


The ADG46X Channel Protectors Use "*Trench Isolation*" to Make Them Latch-Up Proof!

6-31

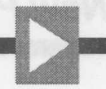
Overvoltage and/or Power Sequencing Protection





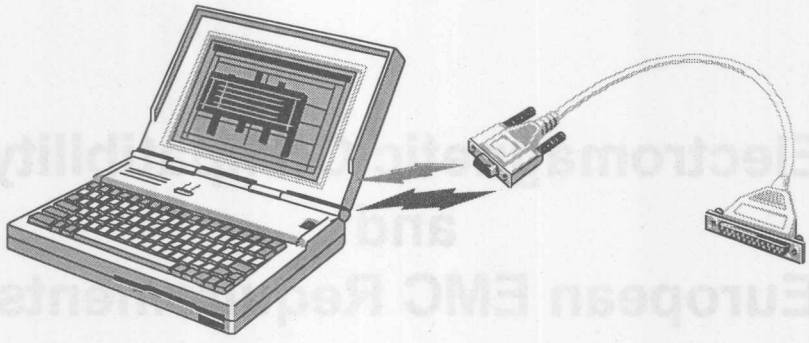
SECTION 7
COMPUTER INTERFACE PRODUCTS

- **Electromagnetic Compatibility (EMC)**
- **European EMC Requirements**
- **RS-232 Line Driver/Receivers**
- **RS-485 Transceivers**
- **V.35 Transceiver**
- **Digital Isolators**



Electromagnetic Compatibility and European EMC Requirements

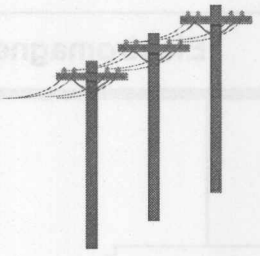
EMC on Interface Products - Why is it so Important?



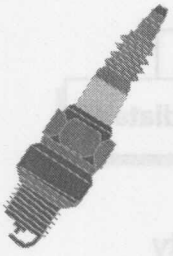
- I-O Transceiver Is Directly in the Firing Line for Transients - RS-232 Port Is Particularly Vulnerable
- I-O Port Is an Open Gateway in the Enclosure
- Harmonised Standards Are Now Mandatory Requirements in European Community

Sources of EMI

RF Interference



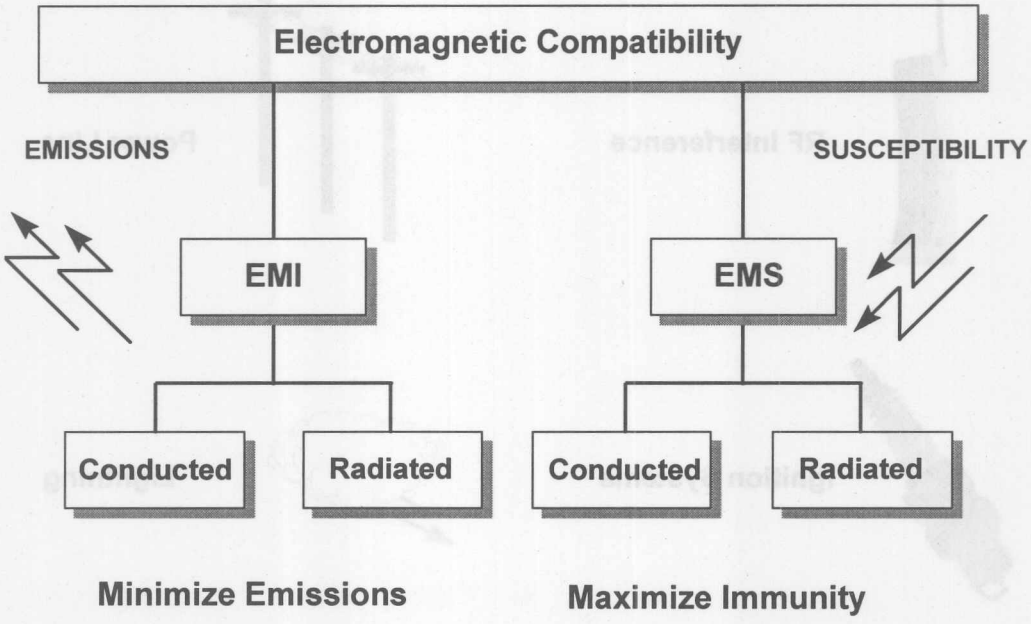
Power Line



Ignition Systems

Lightning

EM Compatibility

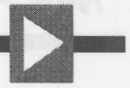


European Requirements - the CE Mark

- **EMC Compatibility**
- **EM Emissions**
- **EM Immunity**
  - **ESD**
  - **EFT**

ElectroMagnetic Compatibility - Definitions

- **Electromagnetic Compatibility (EMC):**
  - **Ability to Operate in, and Not Overly Contribute to, an Environment of Electromagnetic Radiation**
- **Electromagnetic Interference (EMI) :**
  - **Electromagnetic Energy Emanating From One Device Causing Degraded Performance in Another**
- **Electromagnetic Immunity (Susceptibility, EMS) :**
  - **Tolerance in the Presence of Electromagnetic Energy**



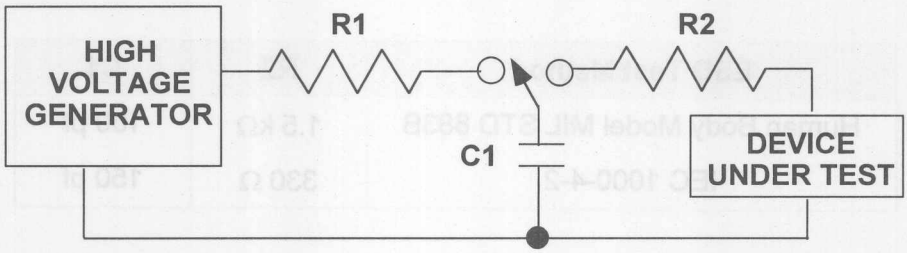
Who Must Comply with the EMC Directive?

- **Manufacturers of Electronic Equipment for:**
  - **Information Technology equipment (ITE)**
  - **Industrial, Scientific, Medical**
  - **Broadcast Receivers**
  - **Household, Appliances, Tools**
  - **Fluorescent Lamps and Luminaries**
  - **Signaling on Power Lines**
- **For Use In:**
  - **Residential/Commercial Environments**
  - **Commercial Environments**
  - **Industrial Environments**

IEC 1000-4-x
Basic Immunity Standards

- **Current Reference Section**
- **IEC1000-4 Electromagnetic Compatibility EMC**
- **IEC1000-4-1 Overview of Immunity Tests**
- **IEC1000-4-2 Electrostatic Discharge Immunity (ESD)**
- **IEC1000-4-3 Radiated Radio-Frequency Electromagnetic Field Immunity**
- **IEC1000-4-4 Electrical Fast Transients (EFT)**
- **IEC1000-4-5 Lightening Surges**
- **IEC1000-4-6 Conducted Radio Frequency Disturbances above 9kHz**

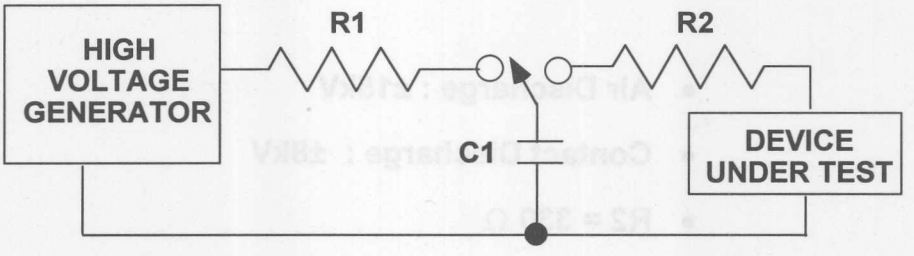
ESD Test Method IEC1000-4-2



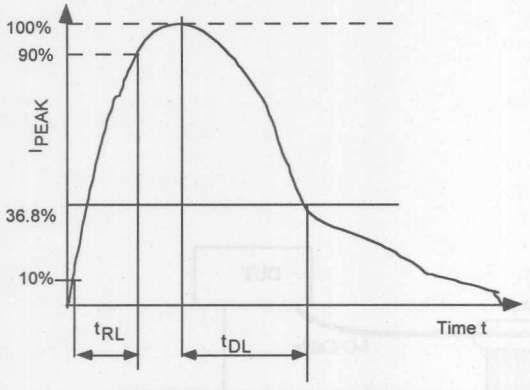
- **Air Discharge : ±15kV**
- **Contact Discharge : ±8kV**
- **R2 = 330 Ω**
- **C! = 150 pF**

IEC1000-4-2 vs. HBM Testing

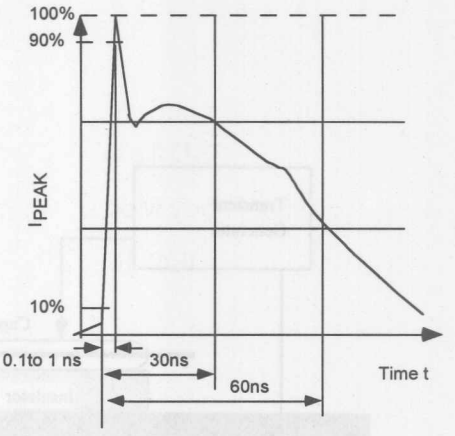
ESD Test Method	R2	C1
Human Body Model MIL STD 883B	1.5 kΩ	100 pf
IEC 1000-4-2	330 Ω	150 pf



ESD Discharge Waveforms



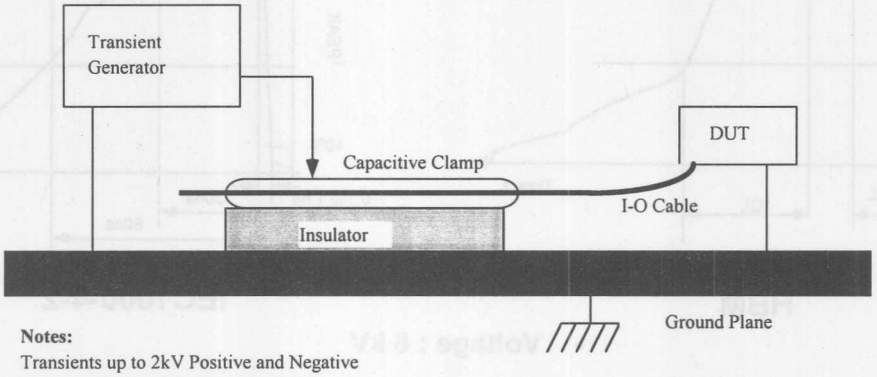
HBM



IEC1000-4-2

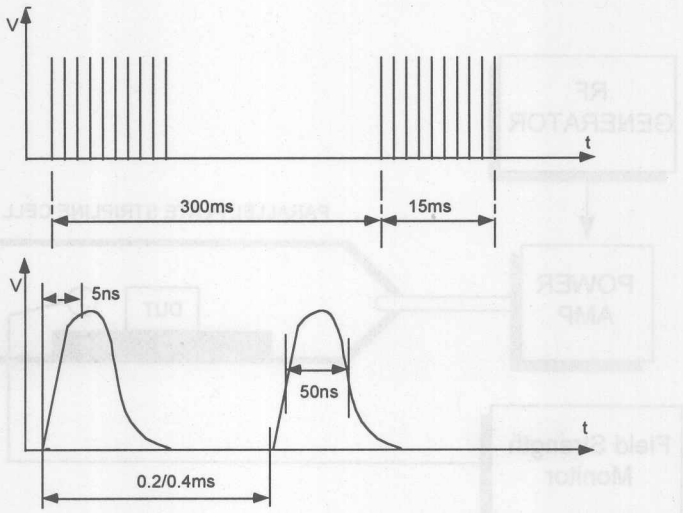
- **Voltage : 8 kV**
- **Peak Current :**
  - **IEC : 25 A**
  - **HBM : 5 A**

EFT Testing



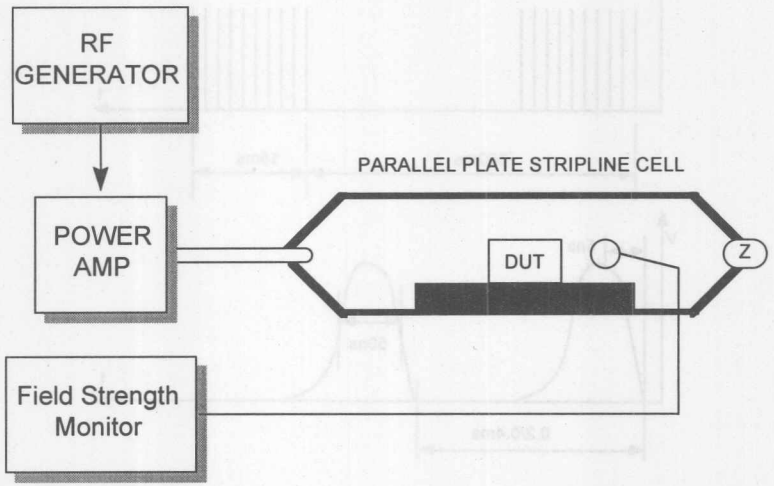
Notes:
Transients up to 2kV Positive and Negative
Device is Powered-Up and Transmitting Data

IEC1000-4-4 EFT



- IEC 1000-4-4 (Previously 801-4)
- EFT Fast Transient Burst Test
- Applied to 1 meter Cable Connected to I-O Lines

1000-4-3 Electric Field Immunity

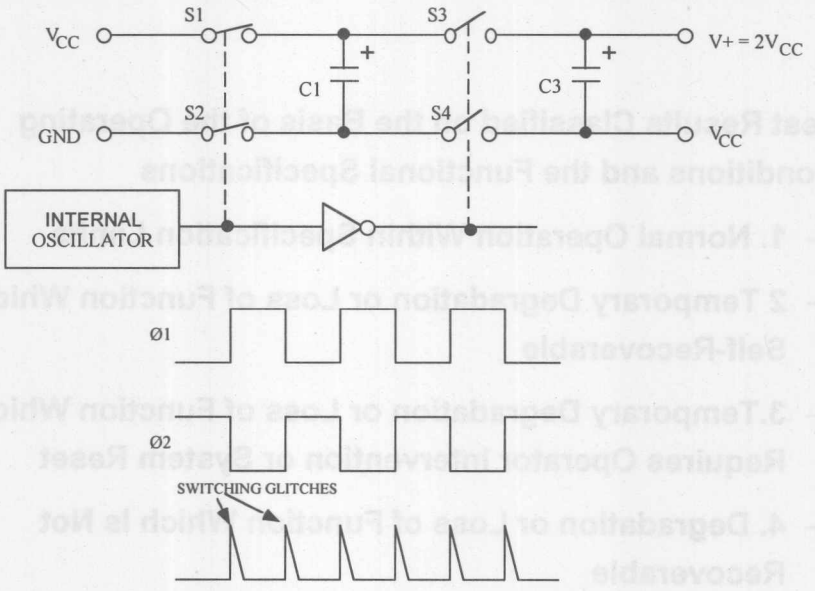


DUT is paced within an electric field

Classification of Results

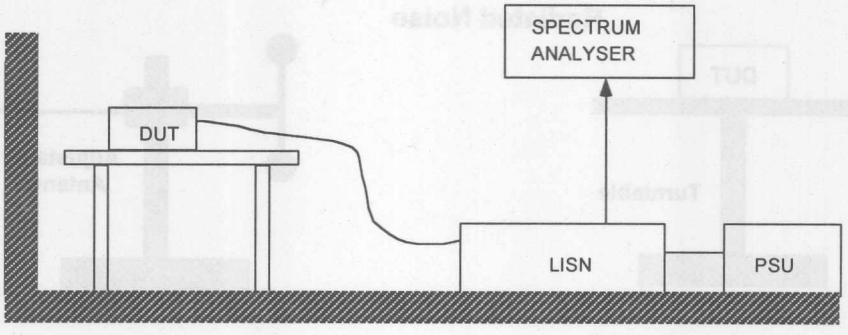
- Test Results Classified on the Basis of the Operating Conditions and the Functional Specifications
  - 1. Normal Operation Within Specification Limits
  - 2 Temporary Degradation or Loss of Function Which Is Self-Recoverable
  - 3.Temporary Degradation or Loss of Function Which Requires Operator Intervention or System Reset
  - 4. Degradation or Loss of Function Which Is Not Recoverable

Source of Conducted Emissions



7 - 18

Conducted Emissions - Testing

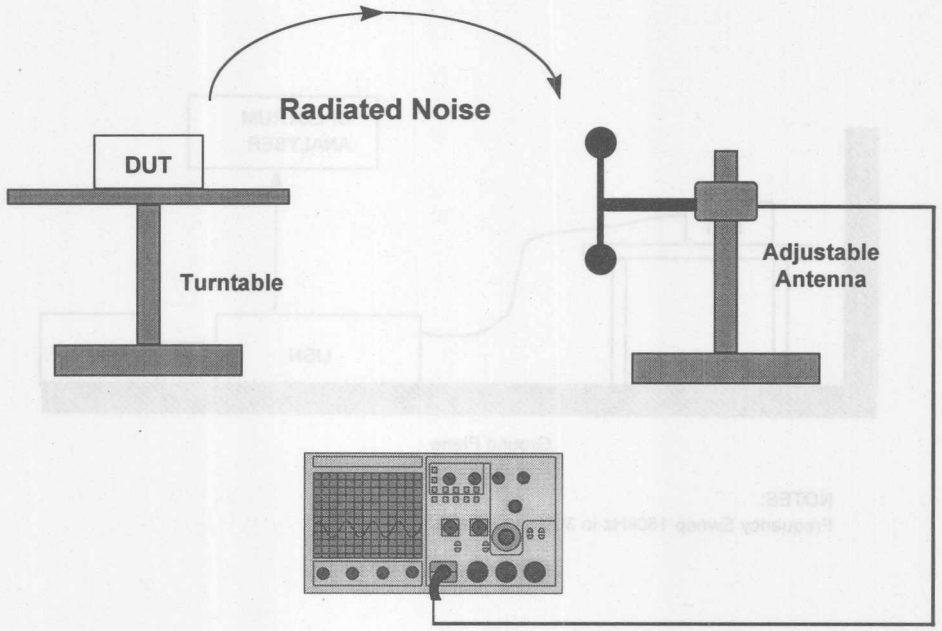


Ground Plane

NOTES:
Frequency Sweep 150kHz to 30MHz BW = 9kHz

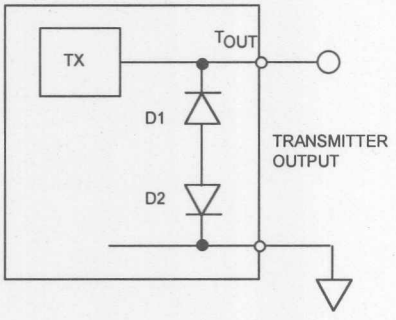
7 - 19

Radiated Emissions Test Setup

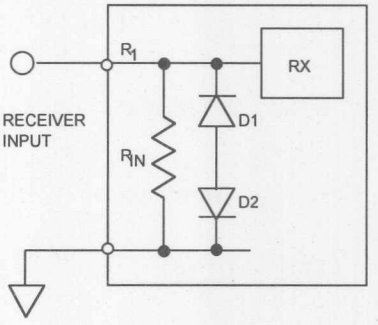


7 - 20

ESD/EFT Protection



Transmitter Output Protection Structure



Receiver Input Protection Structure

7 - 21

RS-232E Line Drivers/Receivers

Preliminary Information

ADM1385, ADM3202 and ADM3222
3V, Low Power RS-232 Transceivers

The ADM1385, ADM3202 and ADM3222 are improved performance upgrades to the LTC1385 and the MAX3222 and MAX3232.

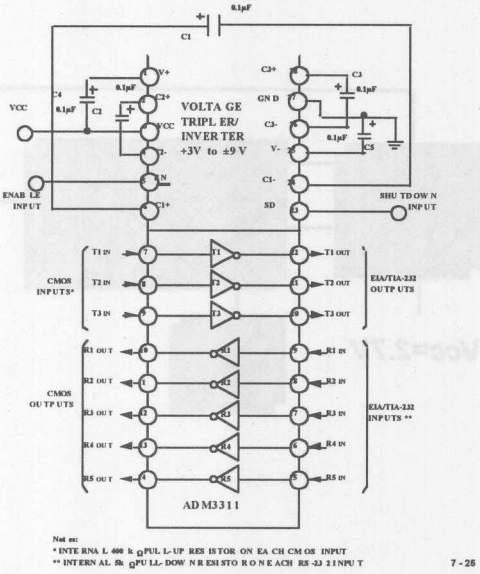
- 2 Drivers and 2 Receivers
- 230 kbits Data Rate Guaranteed!
- Conform to EIA-232E and CCITT V.28
- +3.0 V to +3.6 V Operation
- 2 mA Quiescent Current
- 0.1 uA Shutdown Current (ADM1385, ADM3222)
- 0.1 uF External Charge Pump Capacitors
- ADM1385 : 20 pin SSOP
- ADM3202 : 16 pin DIP, SOIC and TSSOP
- ADM3222 :
  - 18 Pin DIP, SOIC
  - 20 Pin SSOP, TSSOP

7 - 24

ADM3311
Serial Port RS-232 Driver/Receiver

The ADM3311 features a patented Green-Idle™ power saving mode whereby the internal oscillator idles at a minimum frequency (Green-Idle™ mode) to conserve power.

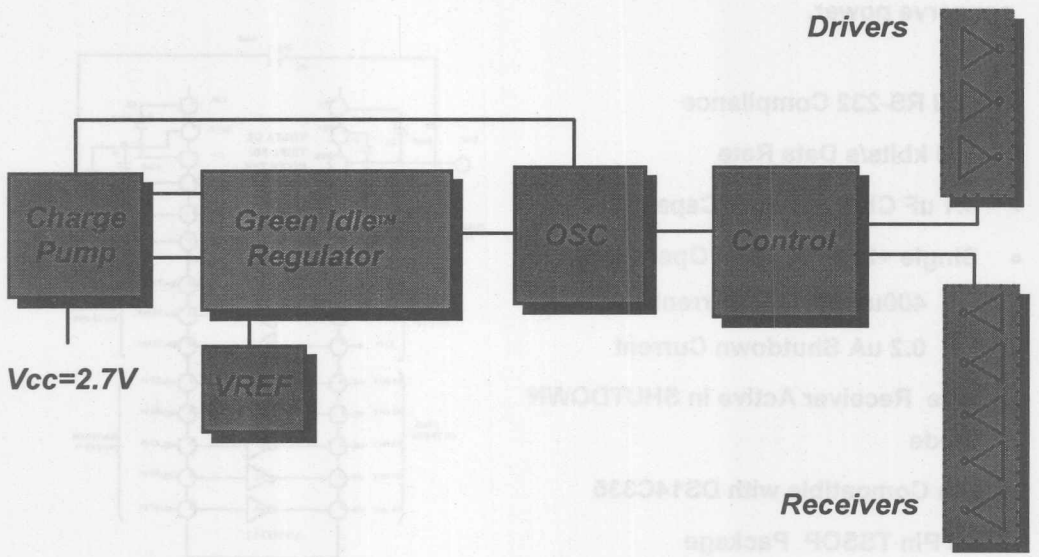
- Full RS-232 Compliance
- 230 kbits/s Data Rate
- 0.1 uF Charge Pump Capacitors
- Single +2.7V to +3.6V Operation
  - 400uA Supply Current
  - 0.2 uA Shutdown Current
- One Receiver Active in SHUTDOWN Mode
- Pin Compatible with DS14C335
- 28 Pin TSSOP Package



Not es:
* INTE RNA L 400 k ΩPUL L-UP RES ISTOR ON EA CH CM OS INPUT
** INTERN AL 5k ΩPU LL-DOW N R ESI STO R O N E ACH RS -23 2 INPU T

7 - 25

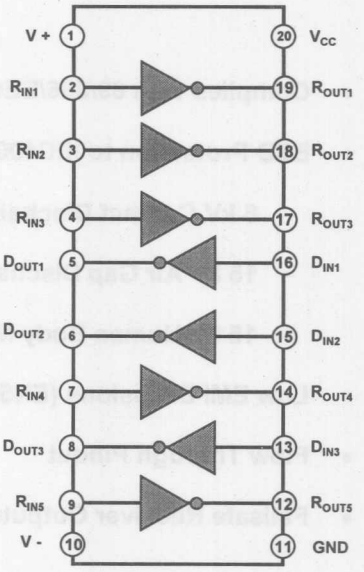
ADM3311 Architecture with Green Idle™



Preliminary Information

ADM14185E and ADM14196E
±15 kV ESD Protected RS-232 Line Drivers/Receivers

- ADM14185E : 3 Drivers/5 Receivers
- ADM14196E : 5 Drivers/3 Receivers
- 230 kbits/s Data Rate Guaranteed
- Conforms to EIA/TIA-232-E
- Laplink® Compatible
- Improved Replacements for DS14185 and DS14196
- Eliminates Costly TransZorbs*
- + 5V and ± 12V Supplies
- 20 Pin SOIC Package



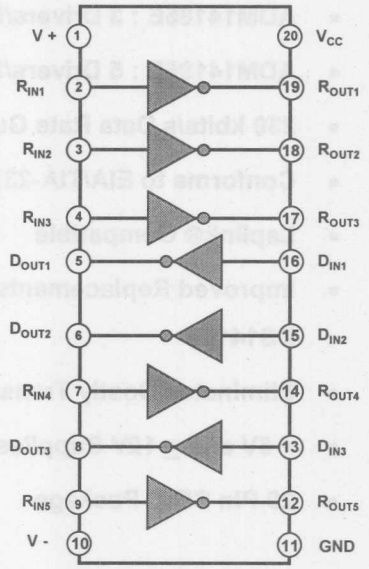
* Trademark of General Semiconductor Corporation

7 - 27

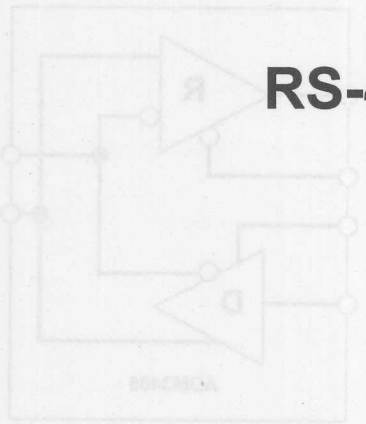
Preliminary Information

ADM14185E and ADM14196E (con't)

- Complies with 89/336/EEC EMC Directive
- ESD Protection to IEC1000-4-2 (801.2):
  - 8 kV Contact Discharge
  - 15 kV Air Gap Discharge
  - 15 kV Human Body Model
- Low EMI Emissions (EN55022)
- Flow Through Pinout
- Failsafe Receiver Outputs



7 - 28

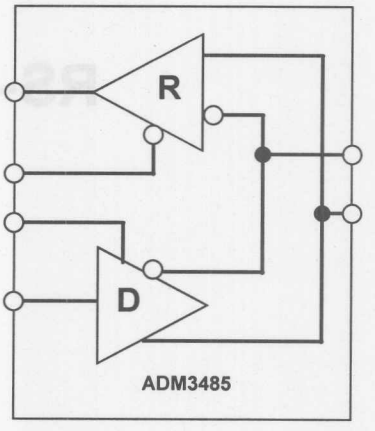


RS-485 Transceivers

ADM3485, ADM3491
3.3V, Full Duplex, 20 Mbps EIA RS-485 Transceivers

The ADM3485 is an improved upgrade to the MAX3485, while the ADM3491 is the recommended upgrade for the MAX3491 and SN75ALS180

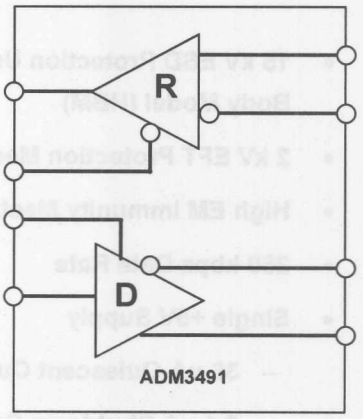
- **EIA RS-422 and RS-485 Compliant over the full CM Range**
- **Meets IEC1000-4-4 (> 1 kV)**
- **20 Mbps Data Rate**
- **8 ns Skew**
- **Interoperable with 5V Logic**
- **19 k ohms Input Impedance Allows Up to 50 Tranceivers on Bus**



7 - 30

ADM3485, ADM3491 (con't)

- Short Circuit Protection
- Thermal Shutdown
- < 1 mA Supply Currents
- 2 nA Shutdown Current
- ADM3485 : 8 Pin DIP, SOIC
- ADM3491 : 14 Pin DIP, SOIC and TSSOP

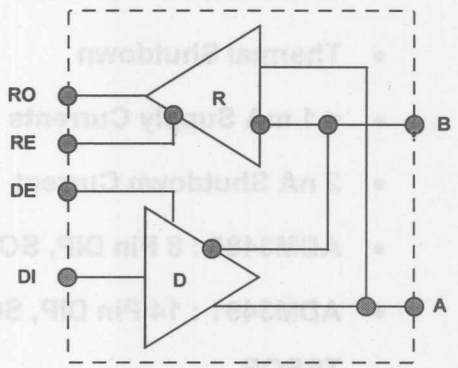


7 - 31

ADM483E
± 15kV ESD Protected EIA RS-485 Transceiver

The ADM483E is a 15 kV ESD plus EMI specified version of our popular ADM485 Transceiver

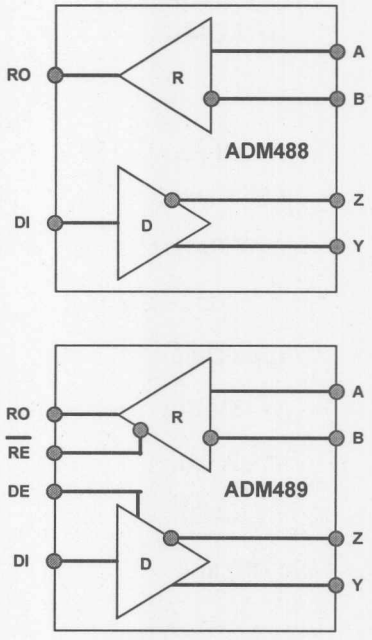
- 15 kV ESD Protection Using Human Body Model (HBM)
- 2 kV EFT Protection Meets IEC1000-4-4
- High EM Immunity Meets IEC1000-4-3
- 250 kbps Data Rate
- Single +5V Supply
  - 36 uA Quiescent Current
  - 0.1 uA Shutdown Current
- 8-Pin DIP and SOIC Packages



7-32

ADM488 and ADM489
Full Duplex, Low Power EIA RS-485 Transceivers

- 250 kbps Data Rate
- Reduced Slew Rate for Low EM Interference
- - 7V to 12 V Bus Common Mode Range
- 12 k Ω Input Impedance
- Short Circuit Protection
- 2 kV EFT Protection Meets IEC1000-4-4
- High EMI Immunity Meets IEC 1000-4-3
- Single + 5V Supply
- 30 uA Supply Current
- ADM488 : 8 Pin DIP, SOIC
- ADM489 : 14 Pin DIP, SOIC; 16 Pin TSSOP



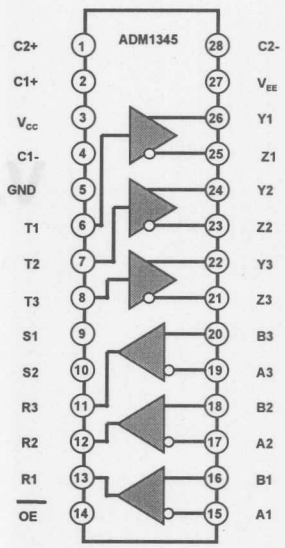
V.35 Transceiver

Preliminary Information

ADM1345
Single Supply, V.35 Transceiver

The ADM1345 is an improved second source to the LTC1345

- 10 Mbaud Minimum Data Rate
- Complies with CCITT V.35 Specification
- Provides All V.35 Differential Clock and Data Signals on One Chip
- Single +5V Supply
- Shutdown Mode Current : 1uA, typ
- Pin-Selectable DCE or DTE Configuration
- ESD Protected Transmitter Outputs and Receiver Inputs up to 10 kV

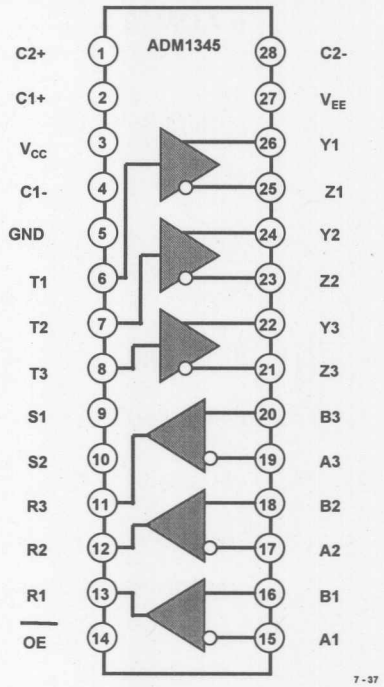


7 - 36

Preliminary Information

ADM1345 (con't)

- Fail-safe Transmitter Outputs are High Impedance When Disabled, Shutdown or Powered Off
- Flow Through Pinout for Easy PCB Layout
- 28 Pin DIP and SOIC Packages
- Operating Temp Ranges :
  - 0 deg C to 70 deg C : JN, JR
  - -40 deg C to 85 deg C : AN, AR

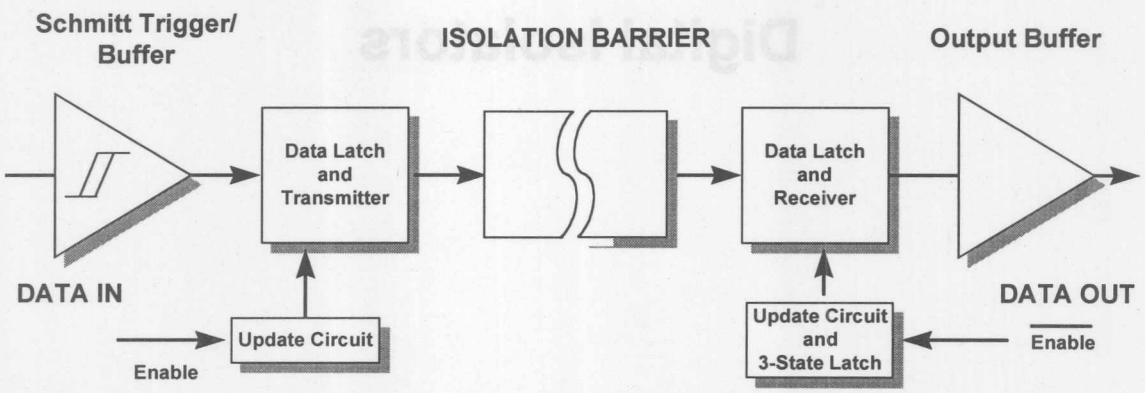


Digital Isolators

preliminary data

AD260**, AD261**
High Speed, High Voltage Digital Logic Isolators

The AD260 and AD261 are 5 channel, high speed logic isolators capable of providing > 4 kV of isolation between a microcontroller's high speed digital I/O lines and its related field I/O components.

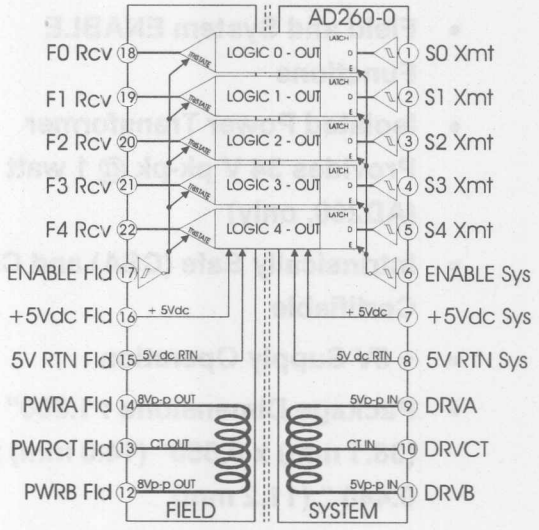


** Advanced Information, Patent Pending

7 - 40

AD260 and AD261
Key Specs and Features

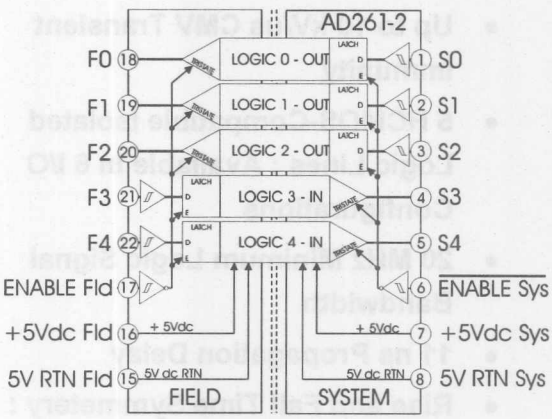
- 3.5 kV Isolation Voltage Range
- Up to 10 kV/us CMV Transient Immunity
- 5 HCMOS-Compatible Isolated Logic Lines : Available in 6 I/O Configurations
- 20 MHz Minimum Logic Signal Bandwidth
- 11 ns Propagation Delay
- Rise and Fall Time Symmetery : ± 2 ns



7 - 41

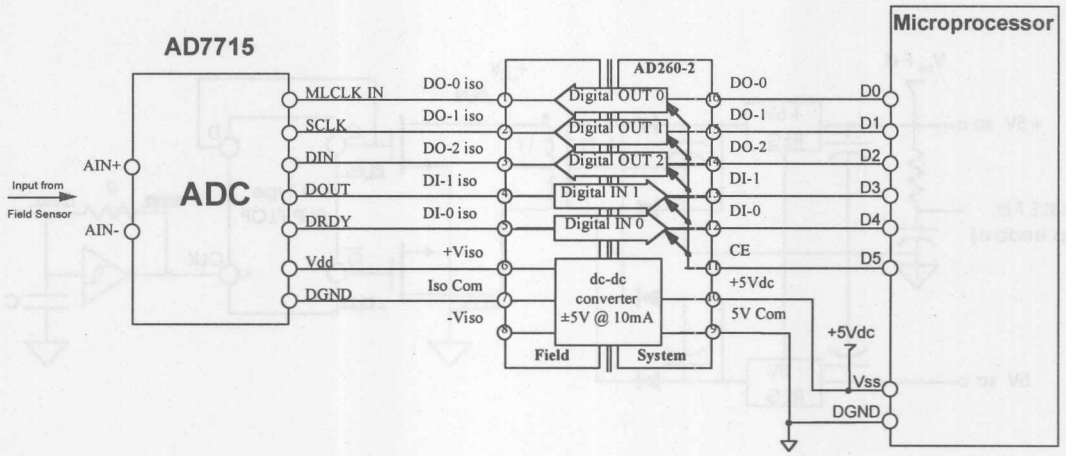
AD260 and AD261
Key Specs and Features (con't)

- **Field and System ENABLE Functions**
- **Isolated Power Transformer Provides 34 V pk-pk @ 1 watt (AD260, only)**
- **Intrinsically Safe (CSA) and CE Certifiable**
- **+ 5V Supply Operation**
- **Package Dimensions : 1.500" (38.1 mm) x 0.550" (14.0 mm) x 0.440 " (11.2 mm)**



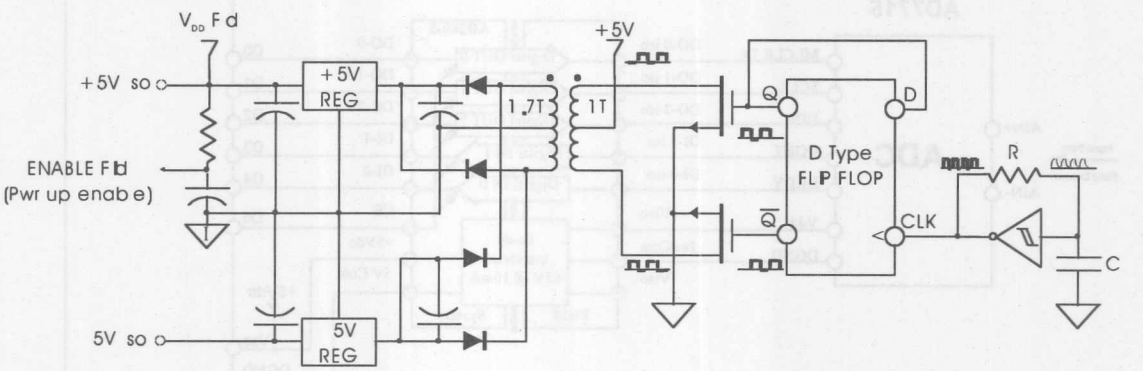
7 - 42

AD260
Isolated Data Acquisition Channel



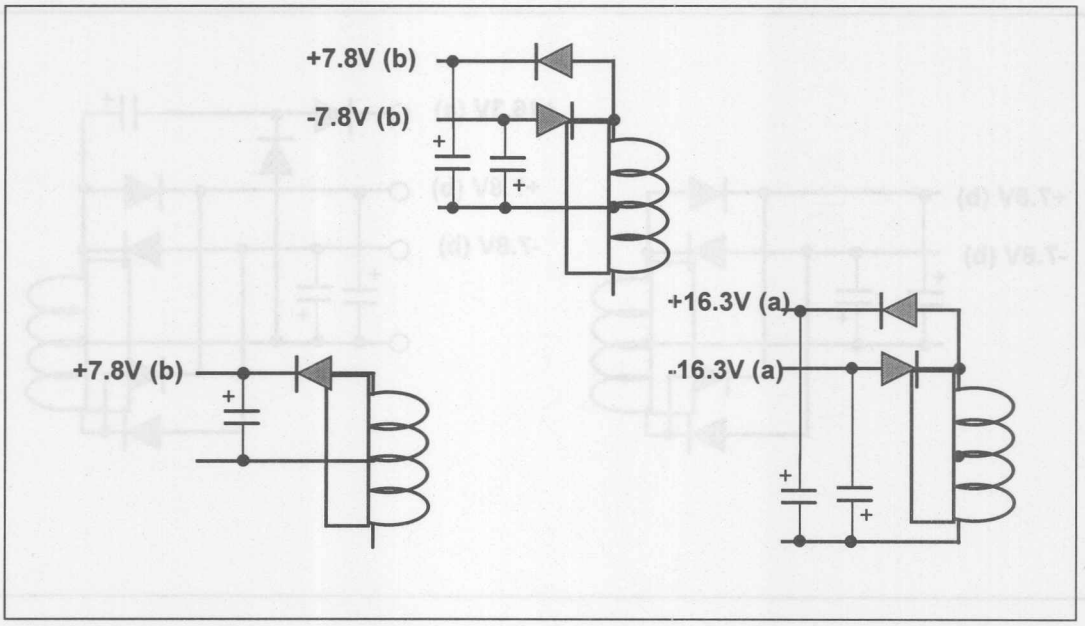
7 - 43

AD260 Isolated Transformer - Typical Drive and Regulation

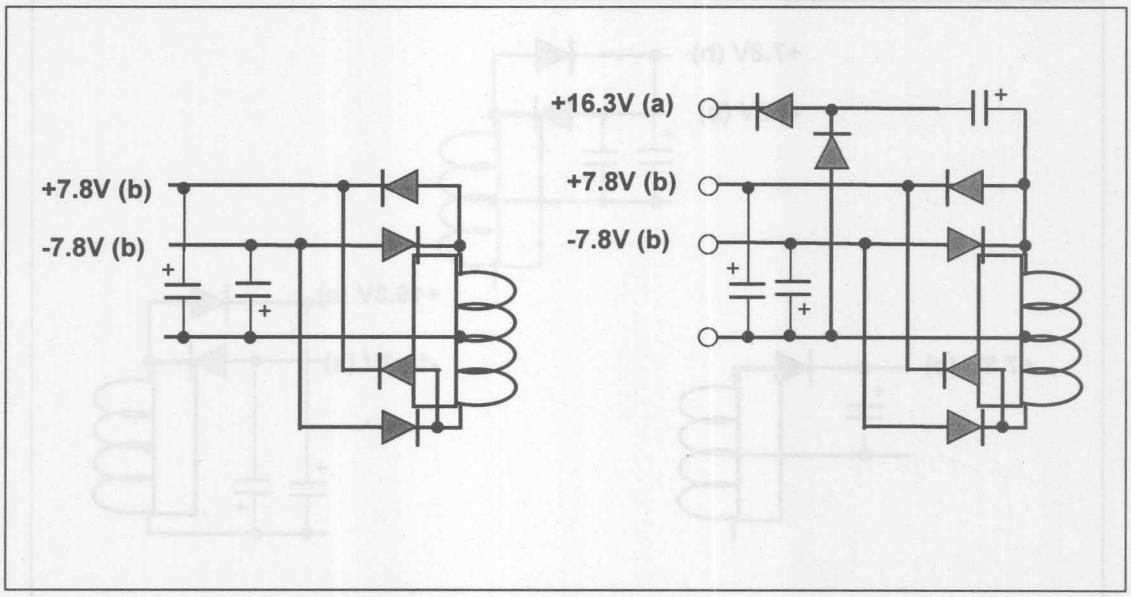


A Half-wave rectified 7-44

AD260 Isolated Transformer - Typical Drive and Regulation (con't)



AD260 Isolated Transformer - Typical Drive and Regulation (con't)



7 - 46

AD260, AD261 - Ordering Guide

Model Number	Model Number	Inputs	Outputs
AD260BND-0	AD261CND-0	0	5
AD260BND-1	AD261CND-1	1	4
AD260BND-2	AD261CND-2	2	3
AD260BND-3	AD261CND-3	3	2
AD260BND-4	AD261CND-4	4	1
AD260BND-5	AD261CND-5	5	0

7 - 47

SECTION 8
POWER MANAGEMENT PRODUCTS

Linear Voltage Regulators

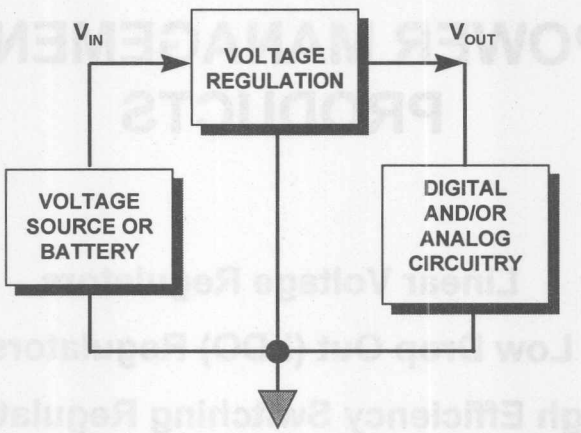
Low Drop Out (LDO) Regulators

High Efficiency Switching Regulators

Charge Pump Converters

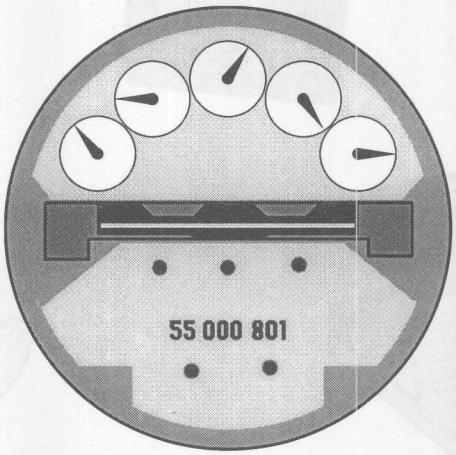
Battery Charger Controllers

What is Power Management?

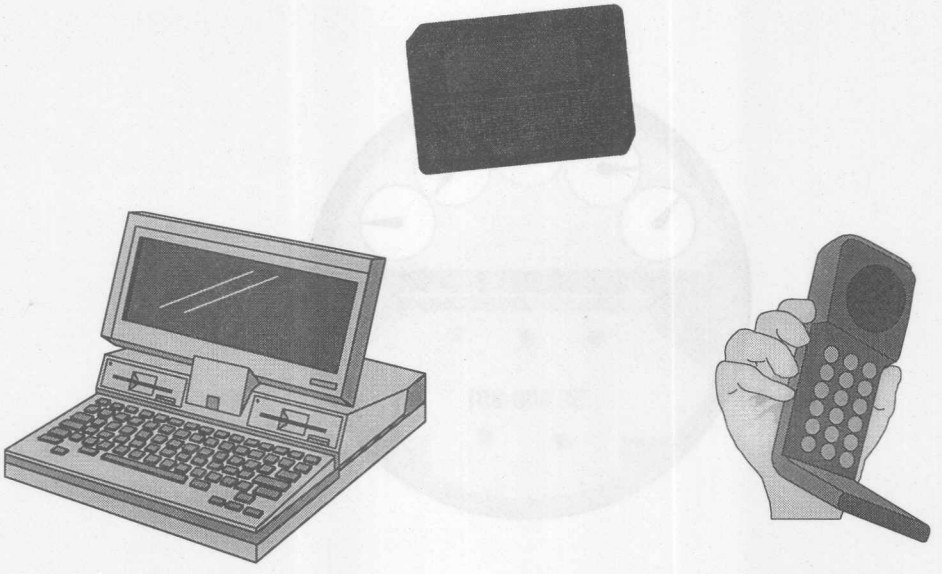


- Maintain Constant V_{OUT} Under Varying Load Conditions or Varying V_{IN}
- Reduce the Number of Independent Power Supplies
- V_{OUT} Can Be Greater Than V_{IN} (Step Up : e.g., 5V $\rightarrow$12V)
- V_{OUT} Can Be Less Than V_{IN} (Step Down : e.g., 12V $\rightarrow$ 5V)
- "DC - DC Converters"

Why is Power Management Becoming So Important?



The World is Going Mobile (Portable) = Battery Powered...



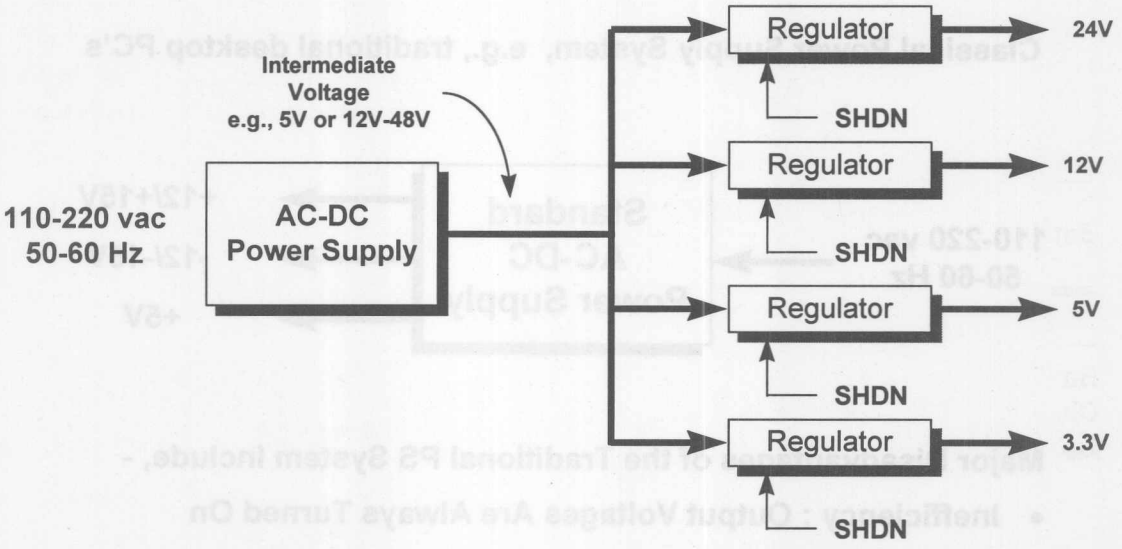
The Move is to a More Efficient, Distributed Architecture...

Classical Power Supply System, e.g., traditional desktop PC's

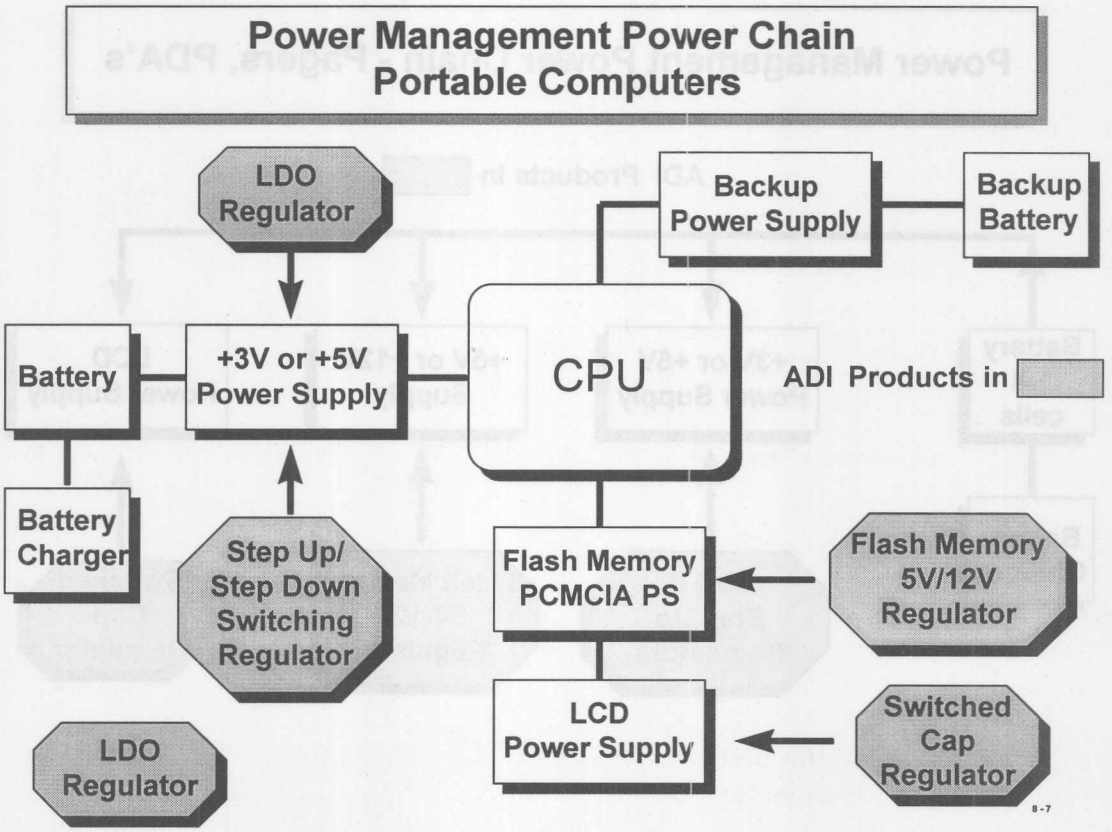
Major Disadvantages of the Traditional PS System Include, -

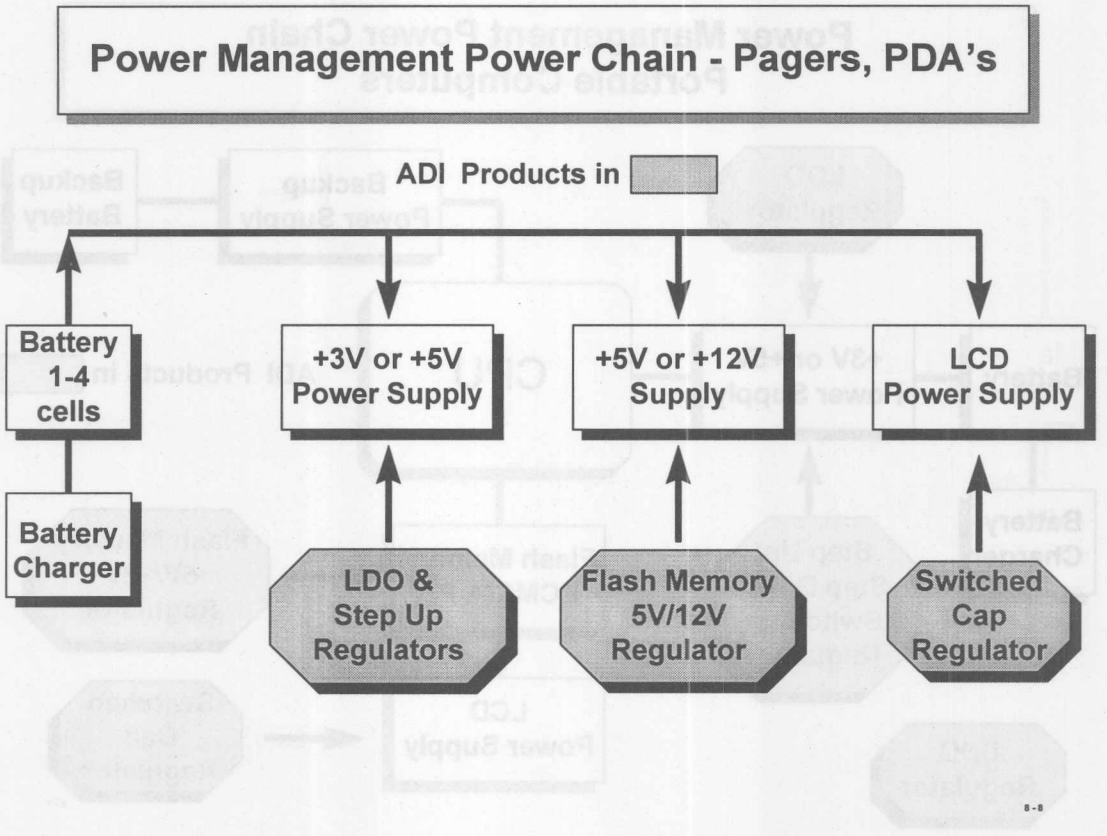
- **Inefficiency : Output Voltages Are Always Turned On**
- **Cable Lengths**
- **Inductance**

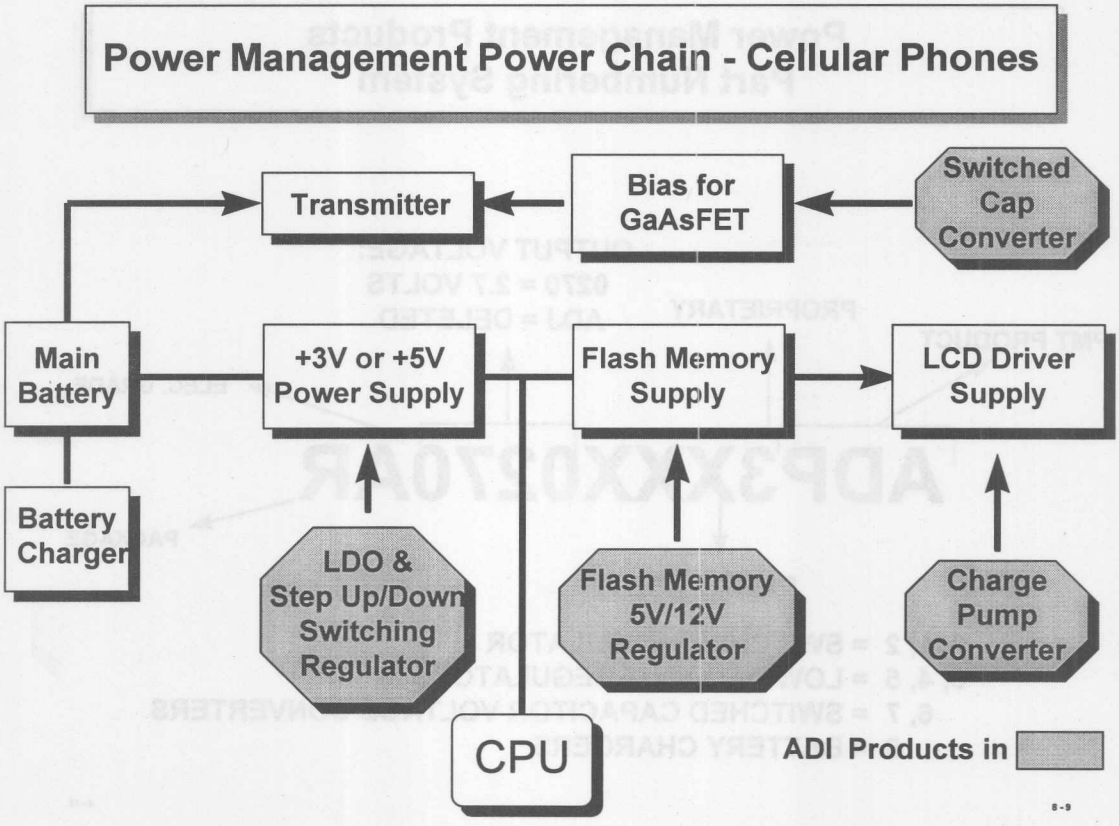
Distributed Power Supply System



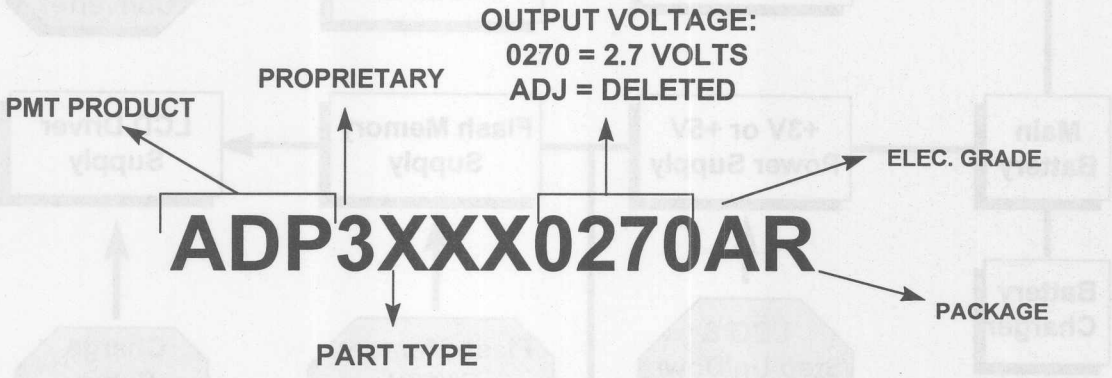
Advantages of the Distributed Power Supply System Include Greater Flexibility and Selective Shutdown


Power Management Power Chain
Portable Computers
LDO Regulator
Backup Power Supply
Backup Battery
Battery
+3V or +5V Power Supply
CPU
ADI Products in
Battery Charger
Step Up/ Step Down Switching Regulator
Flash Memory PCMCIA PS
Flash Memory 5V/12V Regulator
LCD Power Supply
Switched Cap Regulator
LDO Regulator
8-7


Power Management Power Chain - Pagers, PDA's
ADI Products in
Battery 1-4 cells
Battery Charger
+3V or +5V Power Supply
LDO & Step Up Regulators
+5V or +12V Supply
Flash Memory 5V/12V Regulator
LCD Power Supply
Switched Cap Regulator


Power Management Power Chain - Cellular Phones
Transmitter
Bias for GaAsFET
Switched Cap Converter
Main Battery
+3V or +5V Power Supply
Flash Memory Supply
LCD Driver Supply
Battery Charger
LDO & Step Up/Down Switching Regulator
Flash Memory 5V/12V Regulator
Charge Pump Converter
CPU
ADI Products in

Power Management Products
Part Numbering System



0, 1, 2 = SWITCHING REGULATOR
3, 4, 5 = LOW DROPOUT REGULATORS
6, 7 = SWITCHED CAPACITOR VOLTAGE CONVERTERS
8 = BATTERY CHARGERS

8-10

Voltage Regulator Types

- **Linear Regulator:**
  - **Low Cost, Low Noise**
  - **Low Efficiency**
  - **$V_{OUT} < V_{IN}$ (Step Down, Only)**
- **Low Drop Out (LDO) Regulator:**
  - **Best Choice for Operation with Batteries**
  - **Low Noise, Low Quiescent Current**
  - **$V_{OUT} < V_{IN}$ (Step Down, Only)**
  - **Maintains Regulation to Within Small Values of (V_{IN} - V_{OUT}), typ 50-100 mV**

8 - 11

Voltage Regulator Types (con't)

- **Switching Regulators:**
  - **Highest Efficiencies (> 95%)**
  - **Widest V_{OUT} and I_{OUT} Range (>> 100 mA)**
  - **Used with Digital Logic Circuitry**
  - **Immune to HF Switching Noise**

- **Charge Pump Converters:**
  - **"Switched Capacitor" Design**
  - **Higher Efficiencies (> 80%)**
  - **Higher Noise**
  - **Can be up to 300mA. Typically <100mA.**
  - **Output Equals - V_{IN} or 2 x V_{IN}**

8 - 12

VOLTAGE REGULATORS

- ➡ **LOW DROPOUT REGULATORS (LDO)**
- **SWITCH-MODE DC-DC CONVERTERS**
- **SWITCHED CAPACITOR VOLTAGE CONVERTER**
- **BATTERY CHARGER CONTROLLERS**

Why Linear Regulators?

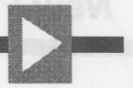
- Simple to Use
- Improved Transient Response
- Fewer Components
- No EMI, RFI

but.....

- Less Efficient Than a Switcher
- Generates More Heat

8 - 14

Analog Devices
anyCAP™*
LDO (Low Drop Out) Regulators

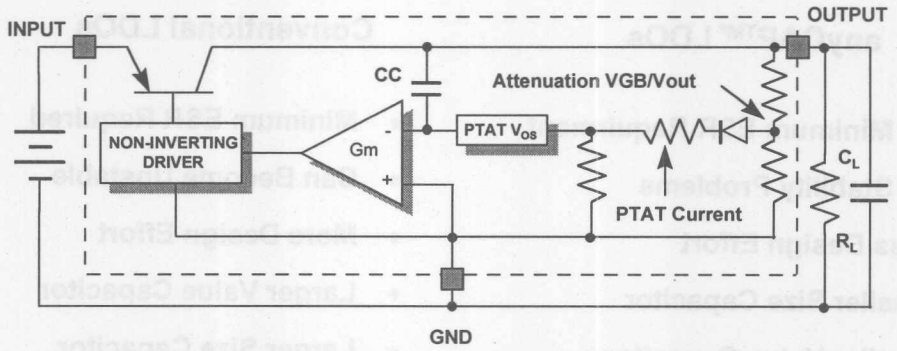


Typical LDOs vs ADI's anyCAP™* LDO

anyCAP™* LDOs	Conventional LDOs
• No Minimum ESR Requirment	• Minimum ESR Required
• No Stability Problems	• Can Become Unstable
• Less Design Effort	• More Design Effort
• Smaller Size Capacitor	• Larger Value Capacitor
• Smaller Value Capacitor	• Larger Size Capacitor
• Less Board Space	• More Board Space
• Lower Cost Capacitor	• Higher Cost Capacitor

8 - 17

ADP3300, ADP3301, ADP3303
anyCAP™* - Low Dropout Linear Regulators



- **80 mV, 100 mV and 180 mV Respective Dropout Voltages @ Rated Output Currents, I_L :**
  - **ADP3300 : 50 mA SOT - 23 Package**
  - **ADP3301 : 100 mA SO - 8 Package**
  - **ADP3303 : 200 mA SO - 8 Package**

*anyCAP is a trademark of Analog Devices Inc.

8 - 18

ADP3300, ADP3301, and ADP3303
Add'l Specs and Features

- anyCAP™* Feature: no minimum ESR required
- High Accuracy : 0.8 %
- Excellent Line & Load Regulation:
  Line : 0.02 mV/Volt Load : 0.06 mV/mA
- 3.0 V to 12 V Input Range
- 2.7V, 3.0V, 3.2V, 3.3V or 5.0V Output Ranges
- Ground Current :
  - 4 mA max @ Rated Output Current, I_L
  - 1 uA max in Shutdown Mode
- 2.5 uA max Output Current in Shutdown Mode
- Output Noise < 200 uV rms
- Short Circuit Protection and Thermal Shutdown

*anyCAP is a trademark of Analog Devices Inc.

8 - 19

ADP3302 anyCAP™* Key Specs and Features

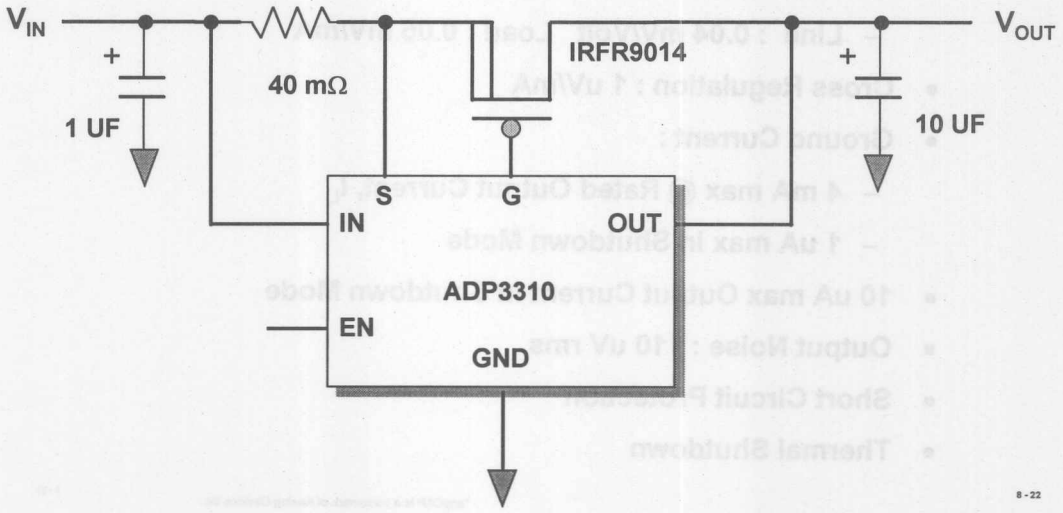
- anyCAP™* Feature : No Minimum ESR Required
- High Accuracy : 0.8 %
- Excellent Line & Load Regulation :
  - Line : 0.04 mV/Volt Load : 0.05 mV/mA
- Cross Regulation : 1 uV/mA
- Ground Current :
  - 4 mA max @ Rated Output Current, I_L
  - 1 uA max in Shutdown Mode
- 10 uA max Output Current in Shutdown Mode
- Output Noise : 110 uV rms
- Short Circuit Protection
- Thermal Shutdown

*anyCAP is a trademark of Analog Devices Inc.

8 - 21

ADP3310
Precision, Voltage Regulator/Controller

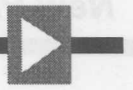
The ADP3310 is a precision voltage regulator controller which may be used with an external power PMOS device to form a 2 chip, low dropout linear regulator that provides up to 1 ampere with only 500 mV dropout voltage!

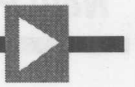


ADP3310 - Key Specs and Features

- High Accuracy : +/- 1.5%
- 2.5 V to 15.0 Volt Input Range
- Output voltage Ranges : 2.8V, 3.0V, 3.3V and 5.0V
- Excellent Line & Load Regulation :
  - Line :+/- 10 mV Max, Vin = Vout + 1Volt $\leq$ 15V
  - Load : +/-10 mV Max, Iout = 10 mA to 1 A
- Quiescent Current :
  - 800 uA typ in Normal Mode
  - 1.0 uA typ in Shutdown Mode
- SO-8 Package

8 - 23





VOLTAGE REGULATORS

- **LOW DROPOUT REGULATORS (LDO)**
- ➡ **SWITCH-MODE DC-DC CONVERTERS**
- **SWITCHED CAPACITOR VOLTAGE CONVERTER**
- **BATTERY CHARGER CONTROLLERS**

Specifying Switch Mode DC-DC Converters (Switching Regulators)

BY FUNCTION:

- Step Down = "Buck"
- Step Up = "Boost"
- Step Up/Down = Buck/Boost
- Invert = Negative Buck/Boost

BY CONTROL METHOD:

- Voltage Mode
- Current Mode
- Pulse Width Modulation

BY MAGNETICS:

- Transformer:
  - Flyback
  - Forward
  - Push - Pull
- Inductor:
  - Buck
  - Boost
  - Buck/Boost

8-26

How to Choose a Switching Regulator

- **Output Current:**
  - **Can It Supply Enough Current for the Circuit (From 1.0 mA to a Few Amps)**
- **Switching Speed:**
  - **Directly Determines the Size of the Inductor, the Higher the Speed, the Smaller the Inductor (75 kHz to 400 kHz)**
- **Required Inductor:**
  - **The Smaller the Better Due to Size and Cost. (10Mh to 120Mh Typical Values)**

8 - 27

How to Choose a Switching Regulator (con't)

- **Efficiency:**
  - **The Higher the Better (> 90% Is Typical)**
- **Output Noise :**
  - **Switchers Generate Output Ripple and Radiated EMI. The Lower the Better.**
- **Features:**
  - **Shutdown - Saves Power and Lower Noise**

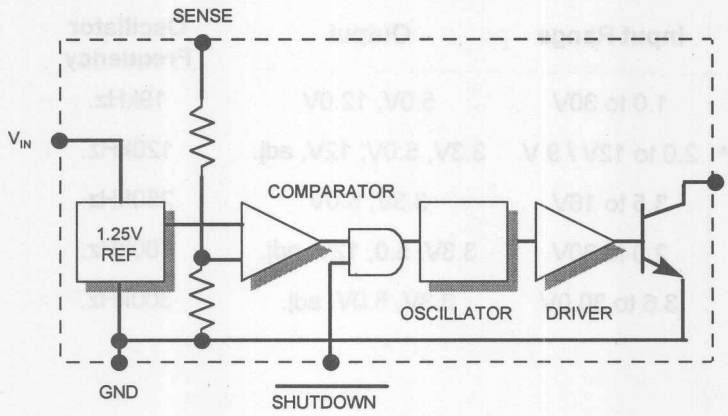
Switch Mode DC-DC Converters

Model	Input Range	Output	Oscillator Frequency	Supply Current
ADP1073	1.0 to 30V	5.0V, 12.0V	19kHz.	130uA.
ADP1109/09A*	2.0 to 12V / 9 V	3.3V, 5.0V, 12V, adj.	120kHz.	460uA.
ADP1147	3.5 to 16V	3.3V, 5.0V	250kHz.	1.6mA.
ADP3000	2.0 to 30V	3.3V, 5.0, 12V, adj.	400kHz.	500uA.
ADP3050	3.6 to 30.0V	3.3V, 5.0V, adj.	300kHz.	15uA.

- **Step Up or Step Down Operation *ADP1109/09A Boost Only.**
- **On-Chip Low Battery Detector**
- **Output Current > 100 mA @ V_{OUT} = 5V and V_{IN} = 12V**
- **User-Adjustable Current Limiting**
- **8 Pin DIP or SO-8 Package**

8-29

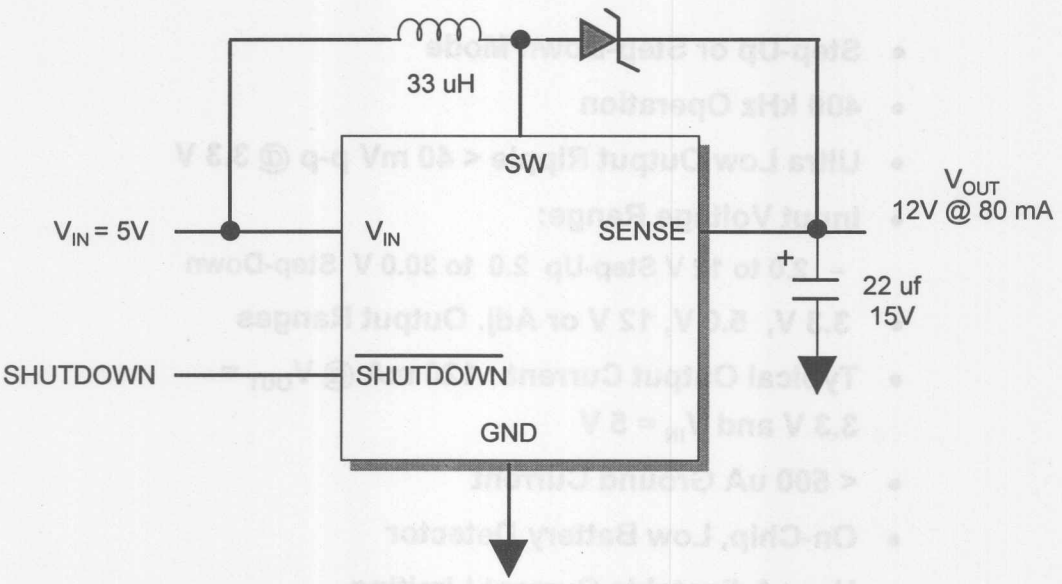
ADP1109 / ADP1109A
Low Cost, Switch-Mode DC-DC Converter



- Step Up Conversion
- 2.0 V - 12 / 2.0- 9.0 V Input Range
- 5 V, 12 V or Adjustable Output Range
- 120 kHz Oscillator Frequency
- SHUTDOWN mode
- Only 320 uA Ground (Quiescent Current)
- Typical Output Current : 100 mA @ V_{OUT} = 5V and V_{IN} = 3V

8-30

Flash Memory VPP Generator



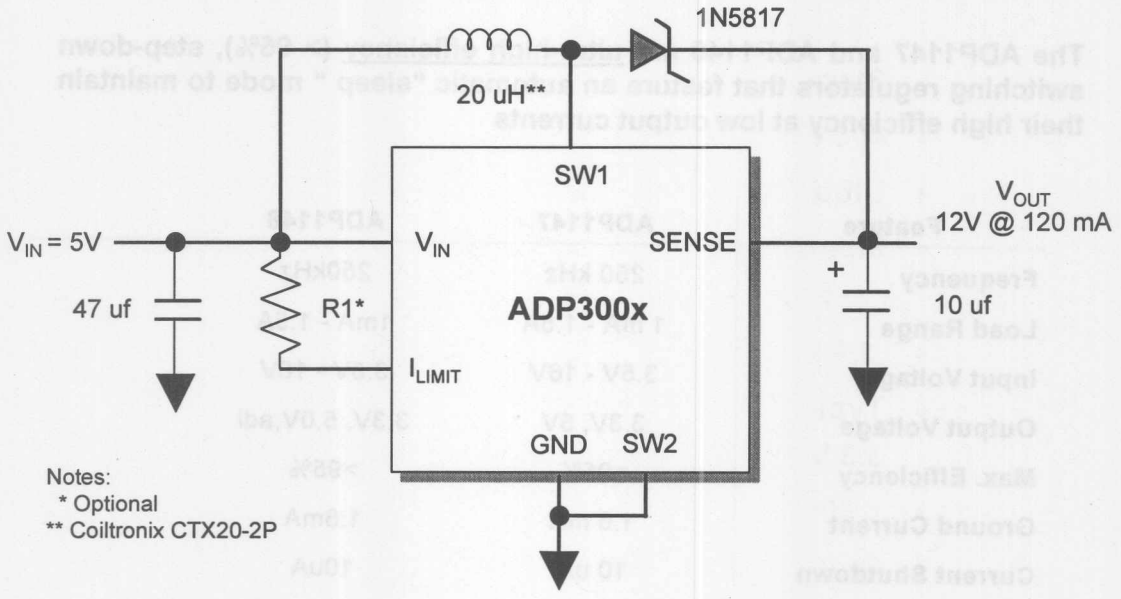
8-31

ADP3000
High Frequency Switching Regulators

- **Step-Up or Step-Down Mode**
- **400 kHz Operation**
- **Ultra Low Output Ripple < 40 mV p-p @ 3.3 V**
- **Input Voltage Range:**
  - **2.0 to 12 V Step-Up 2.0 to 30.0 V Step-Down**
- **3.3 V, 5.0 V, 12 V or Adj. Output Ranges**
- **Typical Output Current : 120 mA @ V_{OUT} = 3.3 V and V_{IN} = 5 V**
- **< 500 uA Ground Current**
- **On-Chip, Low Battery Detector**
- **User-Adjustable Current Limiting**

8 - 32

ADP300x - Application Example



A Step Up DC-DC Converter

8-33

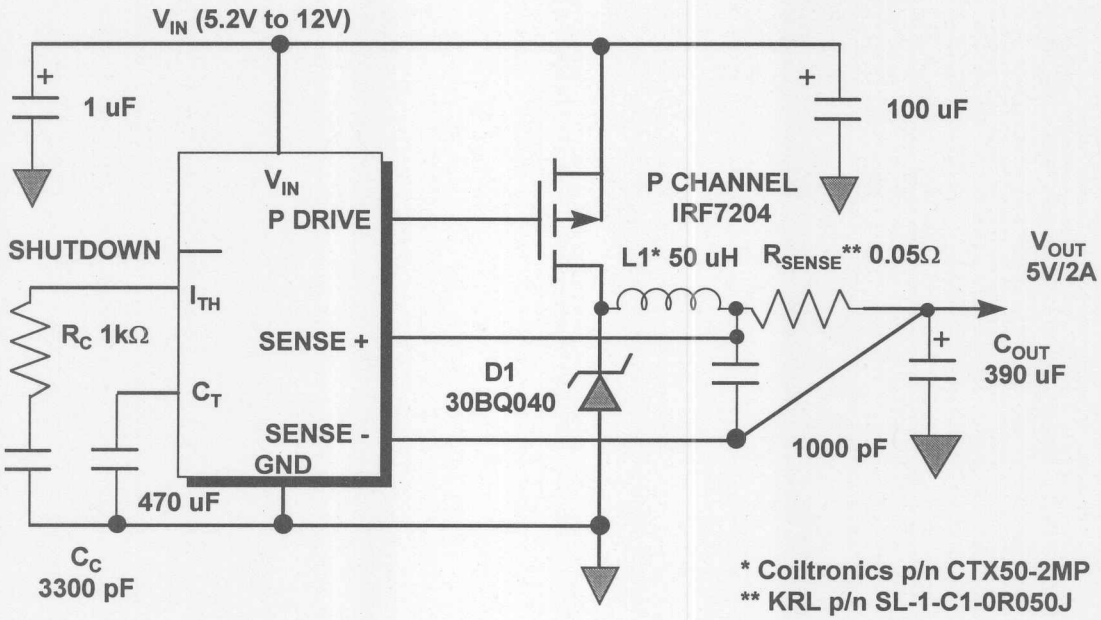
ADP1147 and ADP1148
High Efficiency, Step-Down Switching Regulators

The ADP1147 and ADP1148 are ultra-high efficiency (> 95%), step-down switching regulators that feature an automatic "sleep " mode to maintain their high efficiency at low output currents

Feature	ADP1147	ADP1148
Frequency	250 kHz	250kHz
Load Range	1 mA - 1.5A	1mA - 1.5A
Input Voltage	3.5V - 16V	3.5V - 18V
Output Voltage	3.3V, 5V	3.3V, 5.0V,adi
Max. Efficiency	>95%	>95%
Ground Current	1.6 mA	1.6mA
Current Shutdown	10 uA	10uA

8-34

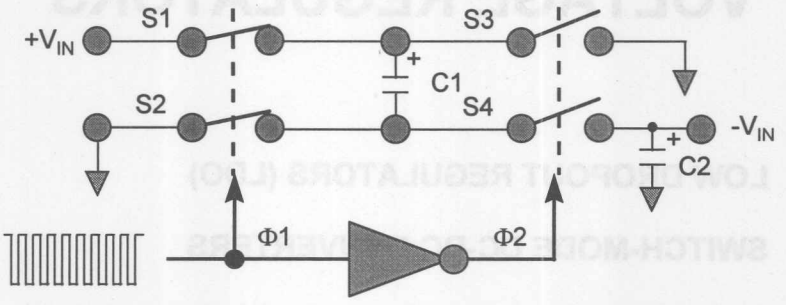
High Efficiency Step-Down Converter



VOLTAGE REGULATORS

- **LOW DROPOUT REGULATORS (LDO)**
- **SWITCH-MODE DC-DC CONVERTERS**
- ➡ **SWITCHED CAPACITOR VOLTAGE CONVERTER**
- **BATTERY CHARGER CONTROLLERS**

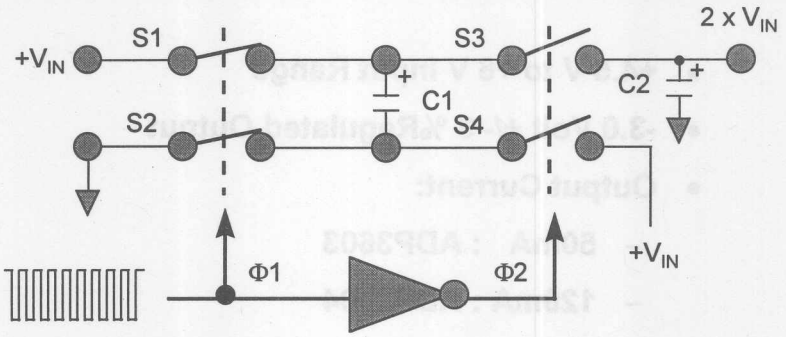
A Switched Capacitor Voltage Inverter



- **When S1 and S2 are closed, and S3 and S4 Open, C1 Charges to q1 = C1 x V_{IN}**
- **When S1 and S2 are Open, and S3 and S4 are Closed, The Charge on C1 is Transferred to C2 and Inverted**

8-38

A Switched Capacitor Voltage Doubler



- **When S1 and S2 are closed, and S3 and S4 Open, C1 Charges to q1 = C1 x V_{IN}**
- **When S1 and S2 are Open, and S3 and S4 are Closed, The Charge from C1 (q1) plus an equal charge q2 (C2 x V_{IN} ;) is Transferred to C2. Since q1 = q2, V_{OUT} = 2 x V_{IN}.**

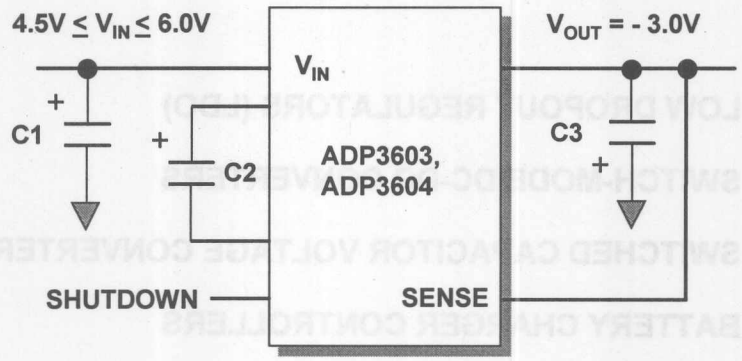
8-39

ADP3603 and ADP3604
Switched Capacitor Voltage Converters

- +4.5 V to +6 V Input Range
- -3.0 Volt +/- 3 %Regulated Output
- Output Current:
  - 50mA : ADP3603
  - 120mA : ADP3604
- High Switching Frequency : 120kHz
- Shut-Down Pin
- Easy-to-Use, No Inductors Required
- 8 Pin SOIC Package

8-40

ADP3603, ADP3604 - Application Example



C1, C2, C3 : 10 uf

8-41

VOLTAGE REGULATORS

- **LOW DROPOUT REGULATORS (LDO)**
- **SWITCH-MODE DC-DC CONVERTERS**
- **SWITCHED CAPACITOR VOLTAGE CONVERTER**
- ➡ **BATTERY CHARGER CONTROLLERS**

ADP3810, ADP3811
Battery Charger Controllers

The ADP3810 is designed for use with Lithium-Ion (Li-Ion) batteries, and provides 4 voltage options : 4.2V, 8.4V, 12.6V and 16.8V.

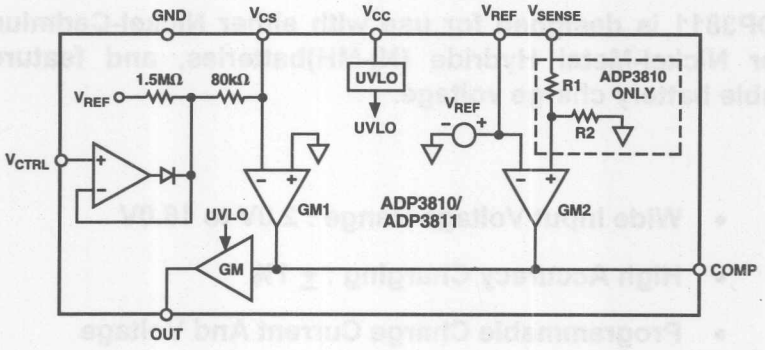
The ADP3811 is designed for use with either Nickel-Cadmium (Ni-Cad) or Nickel-Metal Hydride (Ni-MH)batteries, and features an adjustable battery charge voltage.

- **Wide Input Voltage Range : 2.0V to 16.0V**
- **High Accuracy Charging : ± 1%**
- **Programmable Charge Current And Voltage**
- **Precision 2V Reference : ± 1%**
- **Low Voltage Drop Out Current Sensing**
- **Under-Voltage Lockout**

8-43

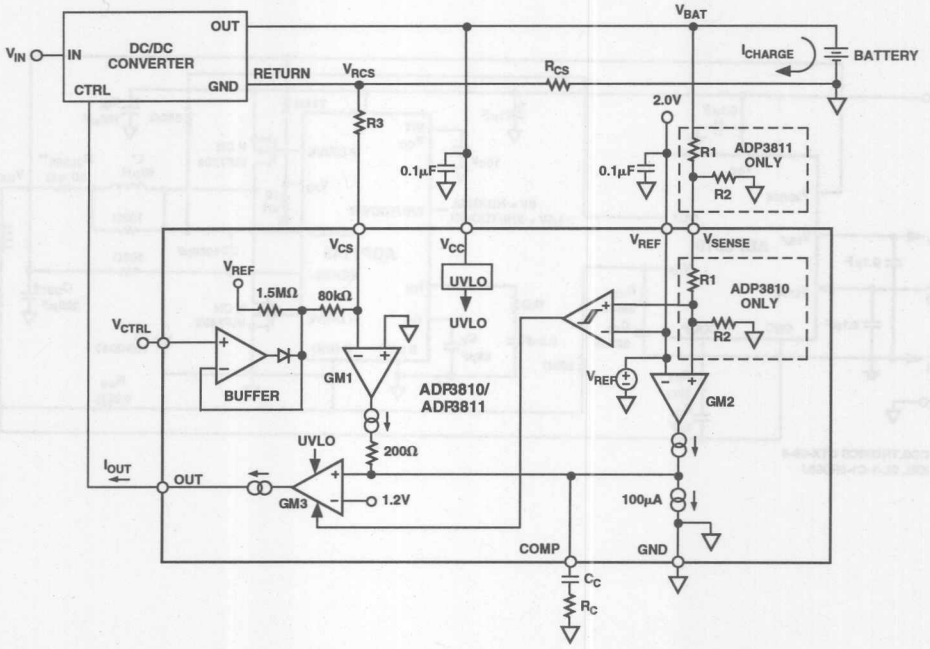
ADP3810, ADP3811 - Block Diagram

FUNCTIONAL BLOCK DIAGRAM

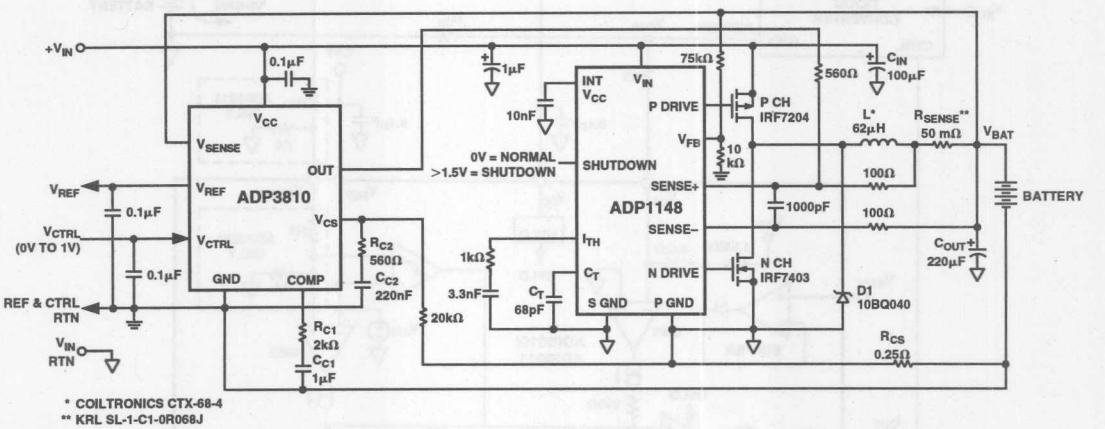


8-44

ADP3810, ADP3811
Simplified Battery Charger Circuit

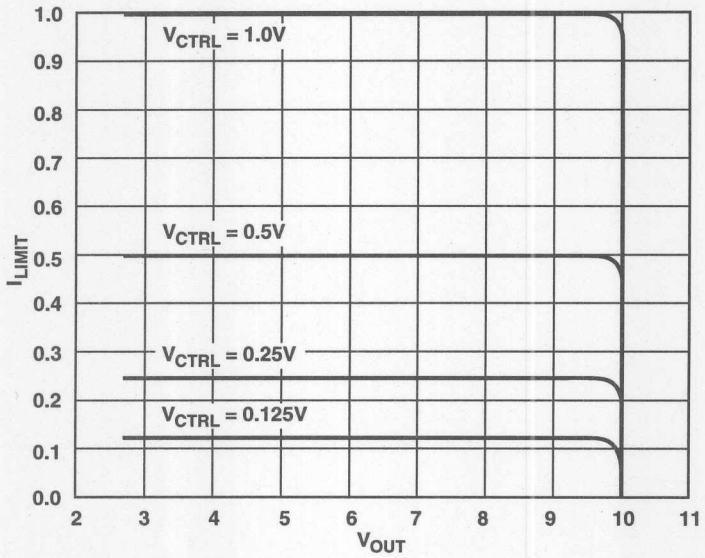


ADP3810, ADP3811
High Efficiency Buck Battery Charger



8-46

ADP3810, ADP3811
Charge Current vs. Battery Voltage with 4 different V_{CTRL} settings



Section 9
Microprocessor Supervisory Components

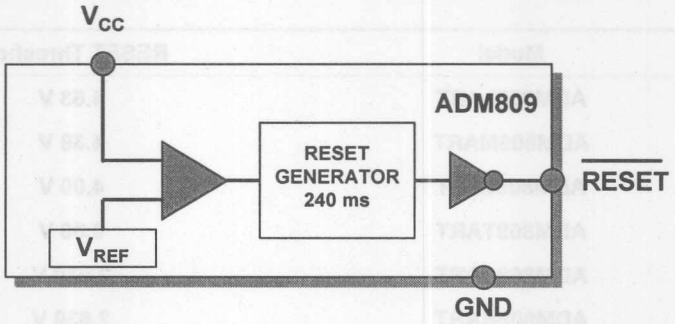
Power Supply Monitors

Supervisory Components

Hardware Monitoring System

Power Supply Monitors

ADM809 and ADM810
V_{CC} Monitors

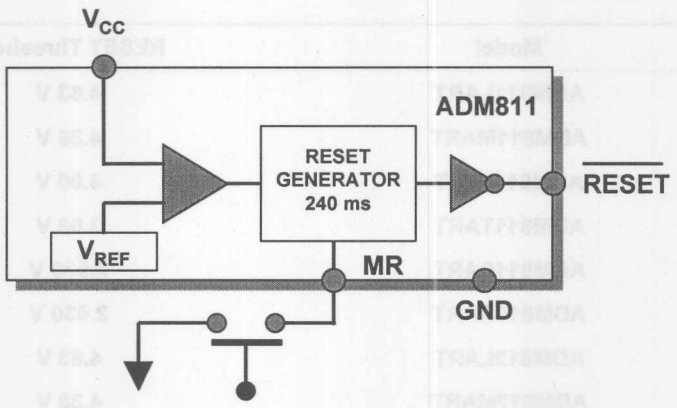


- Precision Voltage Monitor
- Superior Upgrade to MAX809/810
- Logic Low RESET Output (ADM809)
- Logic High RESET Output (ADM810)
- 140 ms Power-On RESET
- Reset Assertion Down to V_{CC} = 1 V
- + 3V, + 3.3V and + 5V Options
- Low Power Consumption : 17 uA

ADM809 and ADM810 Options

Model	RESET Threshold
ADM809LART	4.63 V
ADM809MART	4.38 V
ADM809JART	4.00 V
ADM809TART	3.08 V
ADM809SART	2.930 V
ADM809RART	2.630 V
ADM810LART	4.63 V
ADM810MART	4.38 V
ADM810JART	4.00 V
ADM810TART	3.08 V
ADM810SART	2.930 V
ADM810RART	2.630 V

ADM811 and ADM812
V_{CC} Monitors

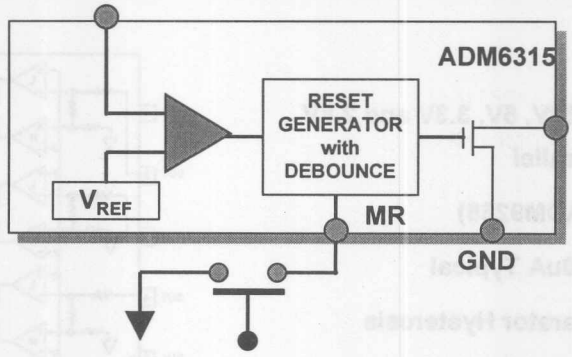


- Precision Voltage Monitor
- Manual RESET
- Logic Low RESET Output (ADM811)
- Logic High RESET Output (ADM812)
- Reset Assertion Down to 1 V V_{CC}
- + 3V, + 3.3V and + 5V Options
- Low Power Consumption : 6 uA
- 4 Pin SOT-143 Package

ADM811 and ADM812 Options

Model	RESET Threshold
ADM811LART	4.63 V
ADM811MART	4.38 V
ADM811JART	4.00 V
ADM811TART	3.08 V
ADM811SART	2.930 V
ADM811RART	2.630 V
ADM812LART	4.63 V
ADM812MART	4.38 V
ADM812JART	4.00 V
ADM812TART	3.08 V
ADM812SART	2.930 V
ADM812RART	2.630 V

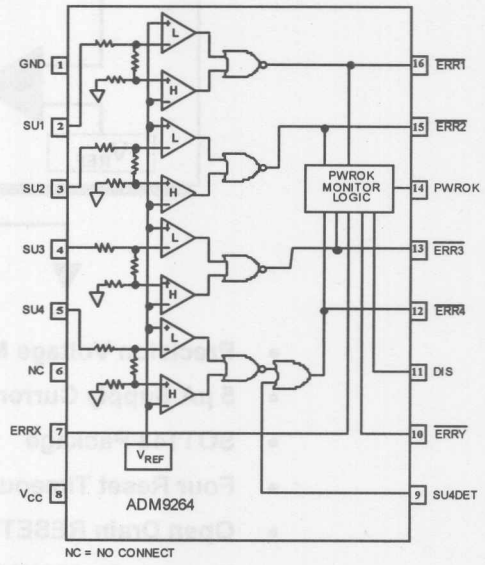
ADM6315
V_{CC} Monitor



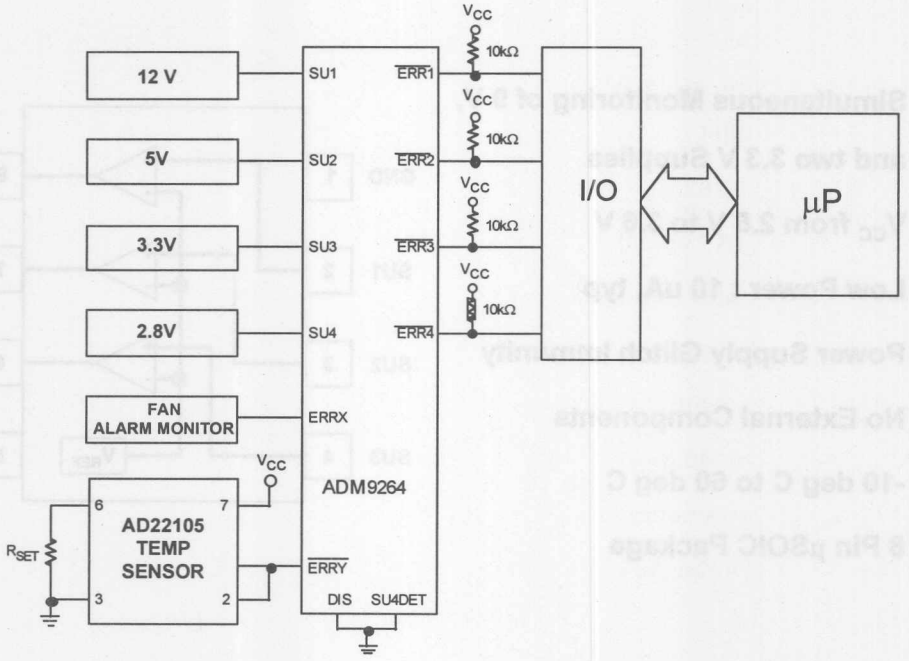
- Precision Voltage Monitor
- 5 µA Supply Current
- SOT143 Package
- Four Reset Timeout Options :1ms, 20ms, 140ms, 1120ms
- Open Drain RESET Output
- Upgrade for MAX6315
- 9 Pin MicroSOIC Package

ADM9264 and ADM9268
Quad Supply Monitors

- Monitoring of 12V, 5V, 3.3V and 2.8V Supplies in Parallel
- I^2C Interface (ADM9268)
- Low Power - 40uA Typical
- Internal Comparator Hysteresis
- Power Supply Glitch Immunity
- V_{CC} from 2.5V to 5.5V
- Guaranteed from -40 deg C to +85 deg C
- No External Components
- 16 Pin SOIC Package (150mil wide)

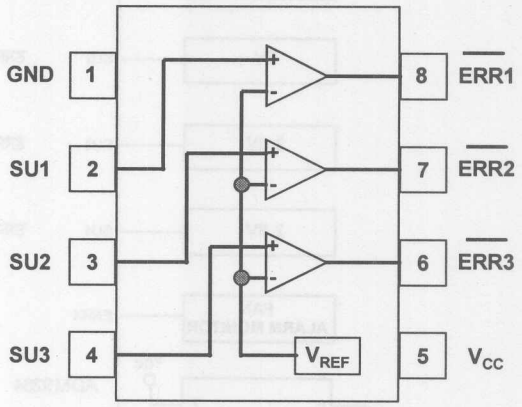


ADM9264 Multi-Supply Monitoring



ADM9261
Triple Power Supply Monitor

- Simultaneous Monitoring of 9 V, and two 3.3 V Supplies
- V_{CC} from 2.5 V to 3.6 V
- Low Power : 10 uA, typ
- Power Supply Glitch Immunity
- No External Components
- -10 deg C to 60 deg C
- 8 Pin μSOIC Package

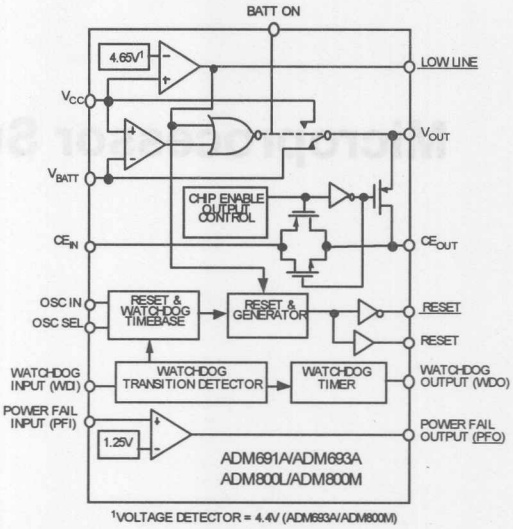


Microprocessor Supervisory Circuits

ADM869X Series
Microprocessor Supervisory Circuits

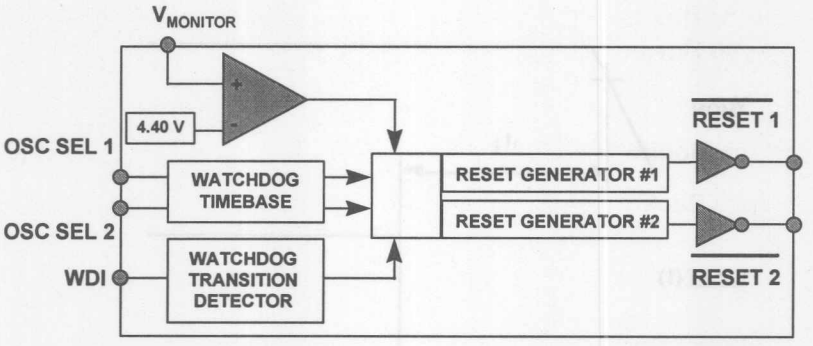
The ADM869X Series are improved accuracy, pin-pin upgrades to our popular ADM690 Series.

- Precision Voltage Monitor
- Automatic Battery BackUp Switching
- Functional at 1V
- Programmable WatchDog Timer
- 1.2Ω R_{ON} Normal Operation
- 12Ω R_{ON} BackUp
- Fast Chip Enable Gating
- Independent Comparator for Advance Power Fail warning



[1]VOLTAGE DETECTOR = 4.4V (ADM693A/ADM800M)

ADM9690
Microprocessor Supervisory Circuit



- **Accurate Voltage Monitor**
- **Watchdog Timer**
- **Selectable watchdog Timeout periods**
- **Two RESET outputs**
- **RESET2 delayed relative to RESET1**

ADM9690
Delayed RESET Timing

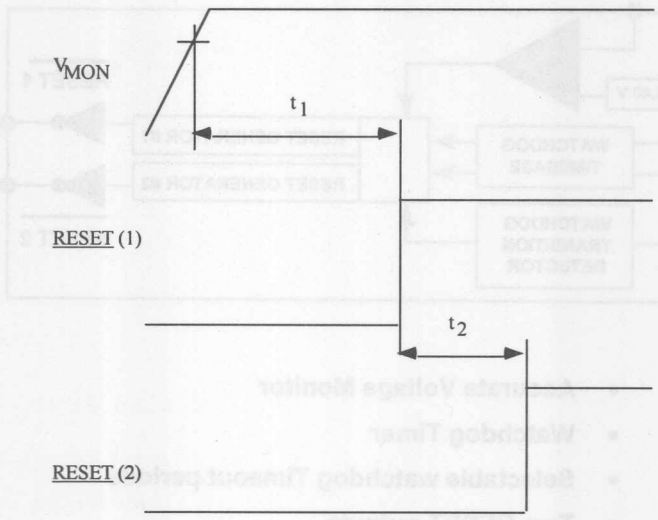
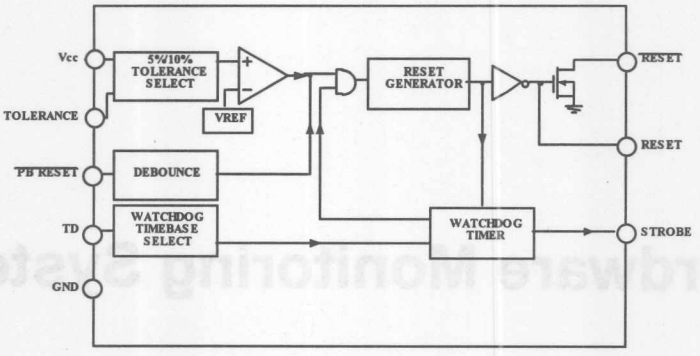


Fig 1. Power-On RESET Timing

ADM1232
Microprocessor Supervisory Circuit



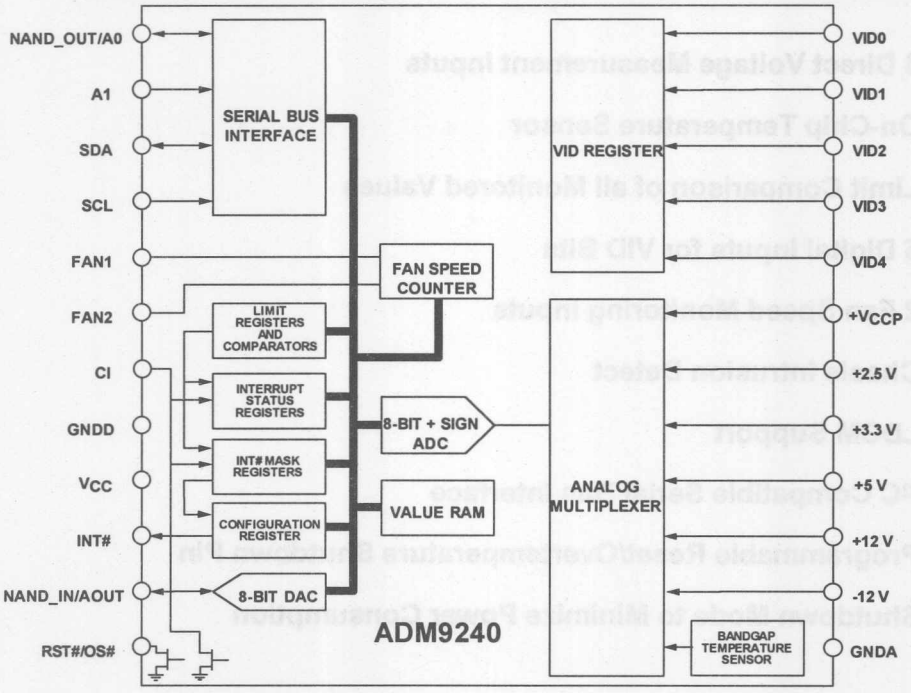
- Precision Voltage Monitor
- 4.5V/4.75V Selectable
- Power-On Reset
- Adjustable Watchdog Timer
- Debounced Manual Reset Input
- Upgrade for Industry Standard DS1232/ MAX1232
- DIP and SOIC Packages

Hardware Monitoring System

ADM9240
ADC Based System Hardware Monitor

- **6 Direct Voltage Measurement Inputs**
- **On-Chip Temperature Sensor**
- **Limit Comparison of all Monitored Values**
- **5 Digital Inputs for VID Bits**
- **2 Fan Speed Monitoring Inputs**
- **Chasis Intrusion Detect**
- **LDCM Support**
- **I²C Compatible Serial Bus Interface**
- **Programmable Reset/Overtemperature Shutdown Pin**
- **Shutdown Mode to Minimize Power Consumption**

ADM9240 Functional Block Diagram



On-Chip Temperature Measurement

- On-Chip Bandgap Sensor Plus ADC (From AD7817)
- -55 Deg C to 125 Degc
- 9 Bit A/D Converter
- 1LSB = 0.5Degree C
- 8-Bit Digital Comparator
  - Prog Overtemperature, Hot Point, Hysteresis
- Interrupt or Overtemp Shutdown

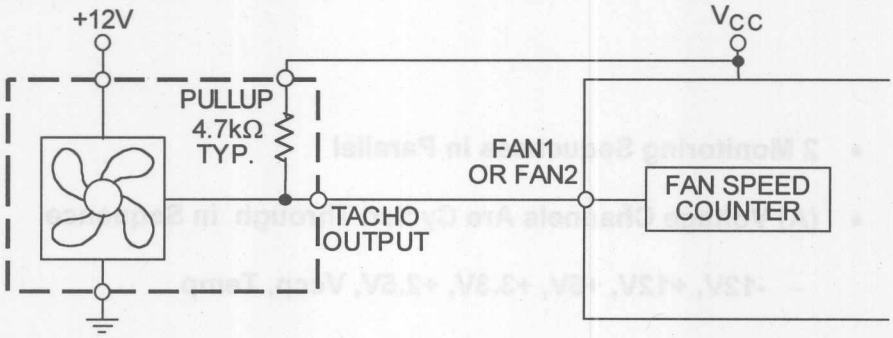
VID Monitoring

V	D4	D3	D2	D1	D0
1.30	0	1	1	1	1
1.35	0	1	1	1	0
1.4	0	1	1	0	0

3.5	1	0	0	0	0

- 5-Bit Voltage -ID Code From Klamath CPU
- Gives Optimum Voltage Required by Core Logic
- Depends on Probe Yield, Clock Speed

Fan Tachometer Input

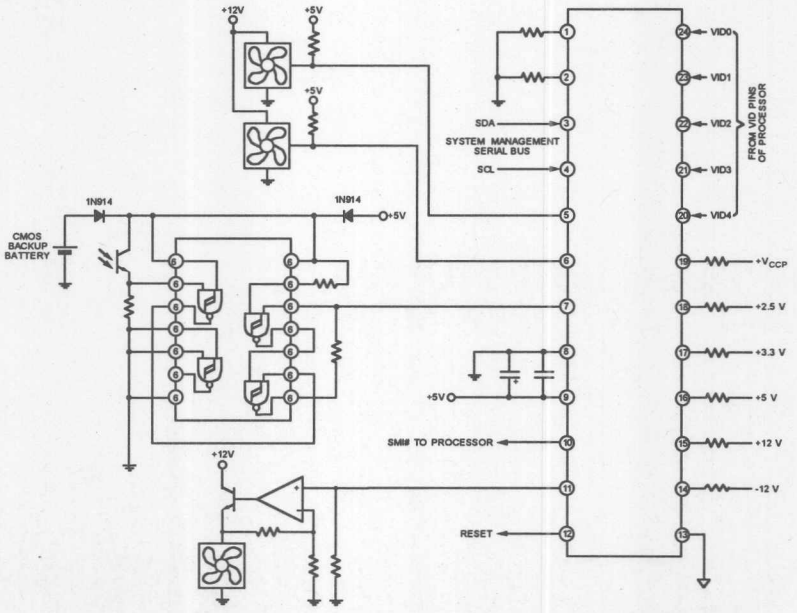


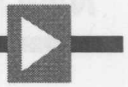
- **Two Tacho Inputs**
  - **Tacho gives two pulses per revolution**
  - **Hysteresis to accommodate slow rise/fall time**
- **Tacho gates internal 22.5kHz Oscillator for one period.**

Monitoring Sequence

- 2 Monitoring Sequences in Parallel
- (A) Voltage Channels Are Cycled Through in Sequence
  - -12V, +12V, +5V, +3.3V, +2.5V, Vccp, Temp
- (B) Fan 1 Speed, Fan2 Speed
- Both Sequences Start Simultaneously

Typical Application



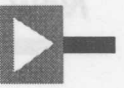


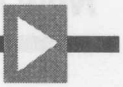
SECTION 10
AUDIO PRODUCTS

Power and Precision Audio Amplifiers

Surround Sound System

Digital Audio Systems

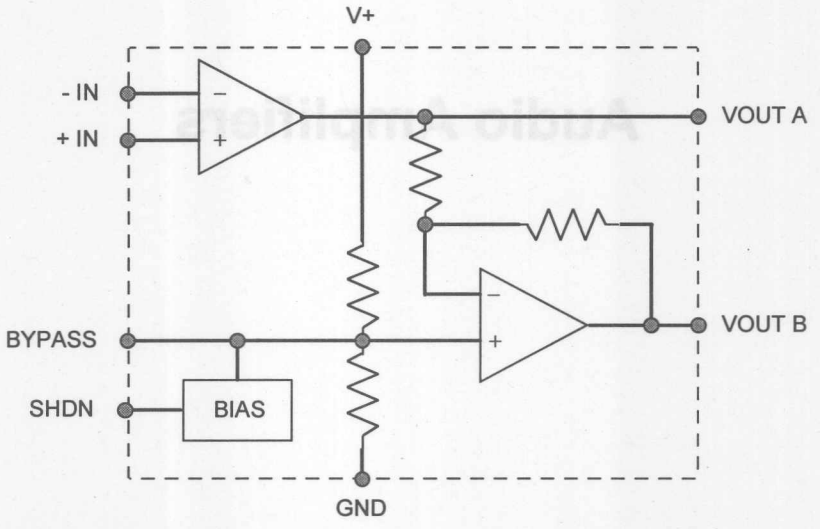




Audio Amplifiers

SSM2211
1 Watt Audio Power Amplifier

Amazing! One watt of power into 8 ohms at less than 1 % THD in an 8 lead, narrow body SOIC package!



SSM2211 - Key Specs and Features

- **Proprietary new Thermal Coastline™ 8 lead SOIC package**
- **Differential Rail-Rail Inputs and Outputs**
- **4 MHz Bandwidth**
- **Low Distortion (into 8 ohms):**
  - **< 0.4% @ 1W**
- **Single Supply Operation : 2.7V to 5.5V**
- **Supply current only 3.5mA**
  - **SHUTDOWN Mode < 100 nA**
- **-40 deg C to + 85 deg C**

10 - 5

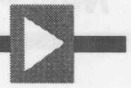
SSM2275 and SSM2475
Dual/Quad *Rail-Rail* Audio Amplifiers

The SSM2275 and SSM2475 are **dual** and quad rail-rail versions of our popular OP275 Audio amplifier

- **Rail-Rail Outputs**
- **Unity Gain Bandwidth : 8 MHz**
- **Slew Rate :11V/us**
- **Total Harmonic Distortion < 0.004%**
- **Noise Density < 7 nV/root Hz**
- **Single (+ 5V) or Dual (± 15V) Supply Operation**
- **Low Supply Current : 3 mA/Amplifier**
- **- 40 deg C to + 85 deg C**
- **8/14 Pin DIP, SOIC and TSSOP Packages**

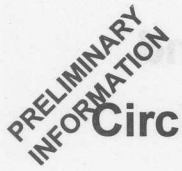
10 - 6

Surround Sound System



Analog Devices' New Circle Surround® Audio Sound System...

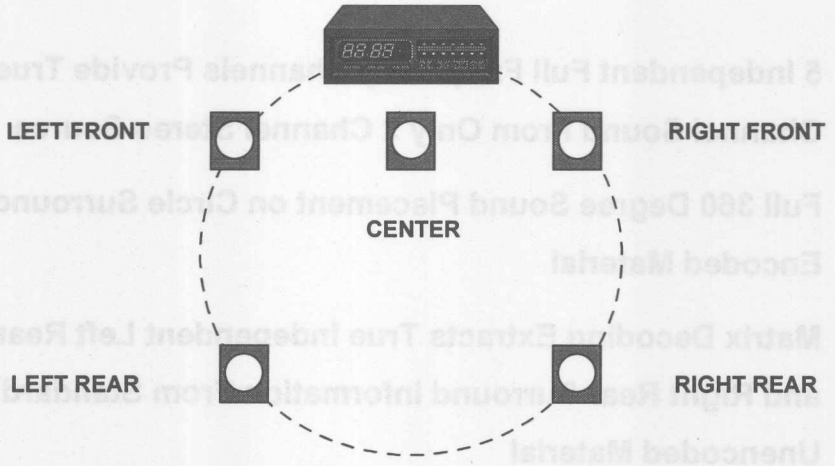
The Most Exciting Development in Audio Entertainment Since the Advent of Surround Sound Technology!



SSM2005
Circle Surround® Audio Surround System

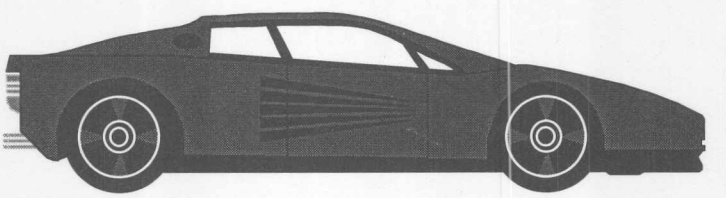
- **5 Independent Full Frequency Channels Provide True 5 Channel Sound From Only 2 Channel Stereo Source**
- **Full 360 Degree Sound Placement on Circle Surround Encoded Material**
- **Matrix Decoding Extracts True Independent Left Rear and Right Rear Surround Information From Standard Unencoded Material**
- **Enhanced Playback of Dolby Prologic® Encoded Material**

Superior Sound for Home Theater and Music Systems...



- **5 Independent Channels for 360 Degree Placement**
- **Full Bandwidth At All Channels for Balanced Sound**
- **Superior Decoding of Prologic® Material**

Superior Sound for Autosound...

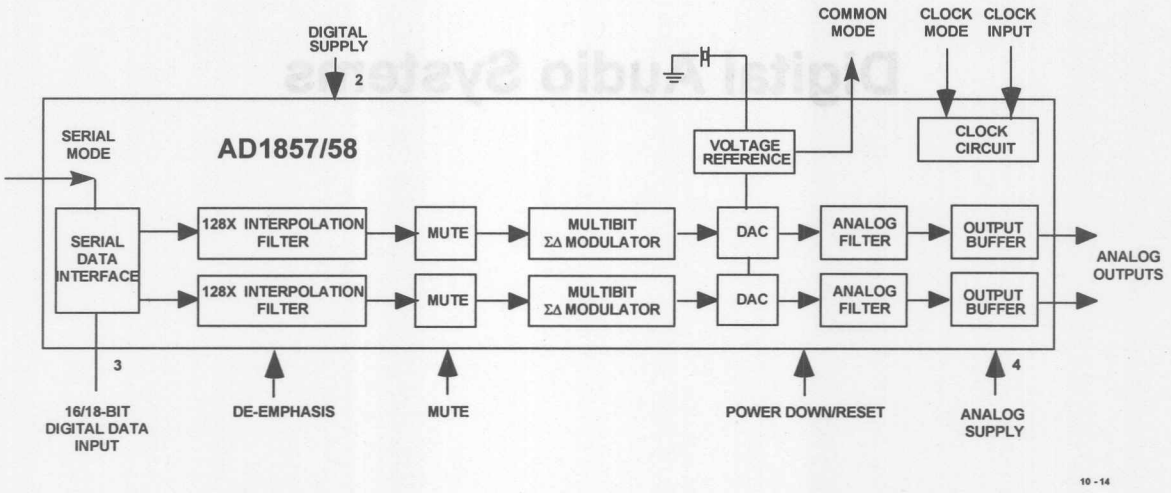


- **Full Bandwidth in Rear Speakers**
- **Every Seat is a Good Seat - Excellent Separation**
- **Surround Sound from AM, FM, Tape and CD!**

Digital Audio Systems

AD1857, AD1858
Low Cost, Integrated Stereo D-A Converters

The AD1857 and AD1858 are low cost, 16/18-bit stereo digital audio playback components.



AD1857, AD1858 - Key Specs and Features

- 128 x F_S Oversampling Digital Interpolating Filter
- Multi-Bit (Σ - Δ) Modulator with Triangular PDF Dither
- Discrete and Continuous Time Analog Reconstruction Filters
- Buffered Outputs with 2k ohm Output Load Drive
- 96 dB Dynamic Range
- THD & Noise > -90 dB
- Digital De-Emphasis and Mute
- ± 0.1 ° Maximum Phase Linearity Deviation Sample Rate

10 - 15

AD1857, AD1858 - Key Specs and Features (con't)

- **Continuously Variable Sample Rate Support**
- **Flexible Serial Data Port:**
  - **AD1857 : 16 bit & 18 Bit I²S-Justified, Left-Justified Modes**
  - **AD1858 : 16 Bit Right-Justified and DSP Serial Port Modes**
- **SPI® - Compatible Serial Control Port**
- **Single + 5V Supply**
- **Power Down Mode**
- **20 Pin SSOP Package**

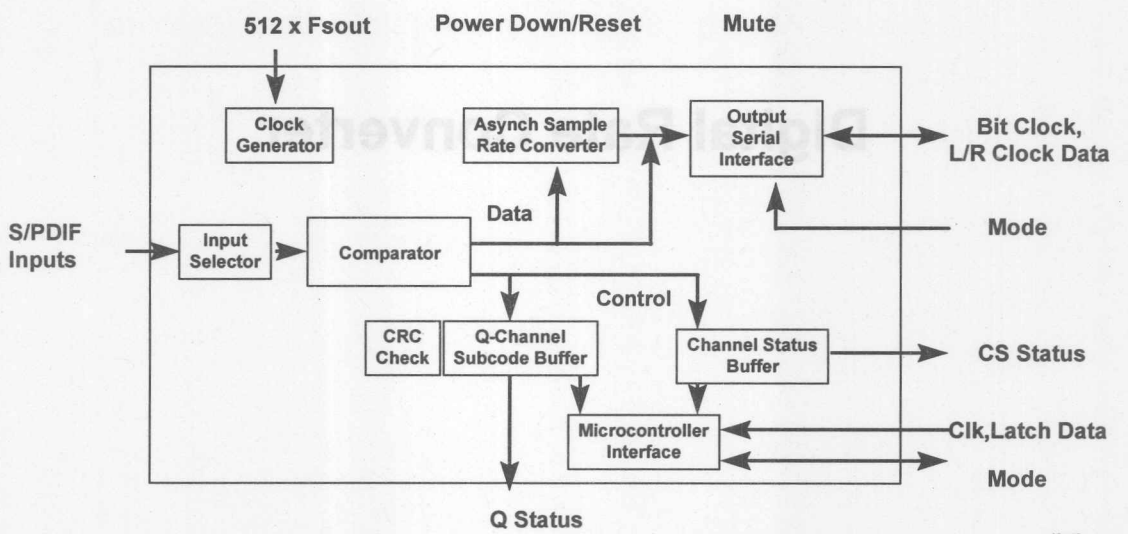
10 - 16

Digital Rate Converter

PRELIMINARY INFORMATION

AD1892
3V Integrated Digital Receiver/Rate Converter

The AD1892 receives and decodes biphase-mark encoded audio and control information while allowing the user to specify the output sample rate.



AD1892 Key Specs and Features

- Complete AES/EBU, S/PDIFCompatible Digital Audio Receiver and Asynchronous Sample Rate Converter
- 16-Bit SamplePort® Architecture Provides Superb Jitter Rejection on Input Port
- Sample Rate Conversion from 8 kHz to 48 kHz
- Buffered Channel Status and Q-Channel Subcode
- 120 dB Dynamic Range
- SPI Compatible Serial Port
- Single +3V to +5V Supply
- Low Power Dissipation : 50 mW
- 28 Pin SOIC Package

10 - 19

SoundPort® Codec

AD1819A
AC'97 SoundPort® Codec

The AD1819 is an analog front end for high performance PC audio, modem, or DSP applications. It is designed to meet all requirements of the Audio Codec '97, Component Specification, Revision 1.03, © 1996, Intel Corporation, found at www.Intel.com.

The AC '97 architecture defines a 2-chip audio solution comprising a digital audio controller, plus a high quality analog component that includes Digital-to-Analog Converters (DACs), Analog-to-Digital Converters (ADCs) mixer and I/O.

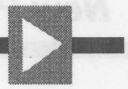
The main architectural features of the AD1819 are the high quality analog mixer section, two channels of ADC conversion, two channels of DAC conversion and Data Direct Scrambling (D2S) rate generators. The AD1819's left channel ADC and DAC are compatible for modem applications supporting irrational sample rates and modem filtering requirements.

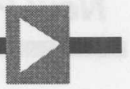
AD1819A - Block Diagram

AD1819A - Key Specs and Features

- **Multi-Bit Σ–Δ Converter Architecture for Improved S/N Ratio > 90 dB**
- **16 Bit Stereo Full Duplex Codec**
- **Four Analog Line-Level Stereo Inputs for Connection from LINE, CD, VIDEO and AUX**
- **Two Analog Line-Level Mono Inputs for Speakerphone and PC BEEP**
- **Mono MIC Input Switchable from Two External Sources**
- **High Quality CD Input with Ground Sense**
- **Stereo Line Level Output**
- **Mono Output for Speakerphone**
- **Power Management Support**

10 - 23





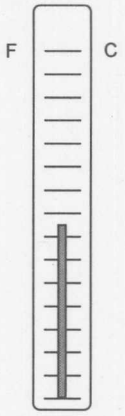
SECTION 11
MONOLITHIC
SENSOR PRODUCTS

Temperature Sensors/Controllers
Monolithic Accelerometers

Temperature Sensors

"Thermal Management"

As the packing density of circuits increases, and more power is dissipated in a smaller volume, thermal management and monitoring becomes essential for early detection and correction of problems.

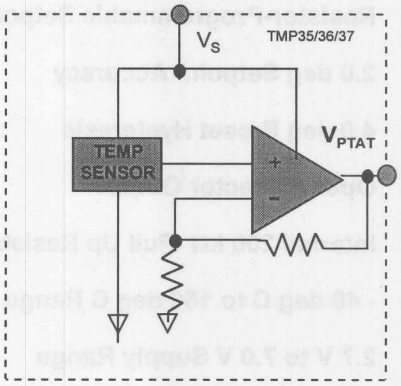


Analog Devices offers a complete family of new, low cost temperature sensors designed to solve a wide range of thermal management applications...

Preliminary Information

ADT45 and ADT50
Low Voltage Temperature Sensors

- Pin and Function Compatible to the LM45 and LM50, Respectively.
- 2.7V to 12V Operation
- < 60 uA Quiescent Current
- 10 mV/deg C Scale Factor
- Accuracy : ± 2%, Typ
- Nonlinearity : ± 0.5%, typ
- Stable with Large Capacitive Loads
- Space-Saving 3 Lead SOT-23 Surface Mount Package
- - 40 deg C to 150 deg C Operation

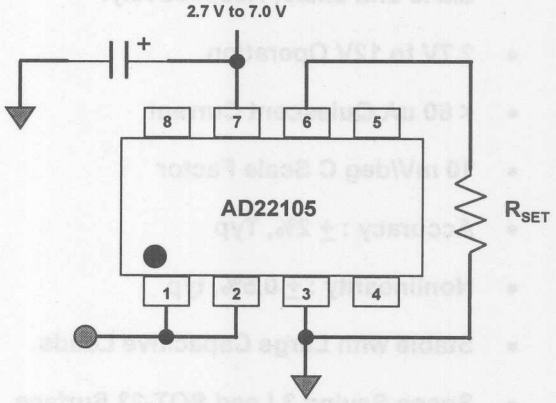


11 - 5

AD22105, ADT05
Resistor Programmable Thermostat

The AD22105 is a low cost, reliable alternative to electro-mechanical thermostatic switches. The ADT05 is a SOT-23 5 pin version of the AD22105

- Resistor-Programmable Setpoint
- 2.0 deg Setpoint Accuracy
- 4.0 deg Preset Hysteresis
- Open Collector Output
- Internal 200 kΩ Pull Up Resistor
- - 40 deg C to 150 deg C Range
- 2.7 V to 7.0 V Supply Range
- Low Power : 230 uW @ 3.3 V
- 8 Lead SOIC Package

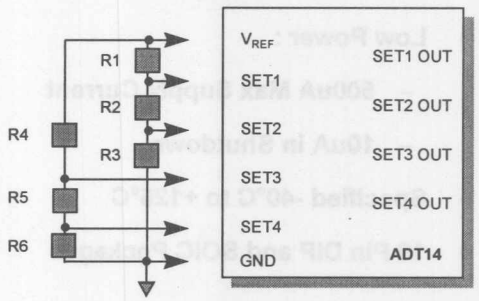


11 - 6

Preliminary Information

ADT14, ADT15
Quad Setpoint, Programmable Temperature Monitor/Controller

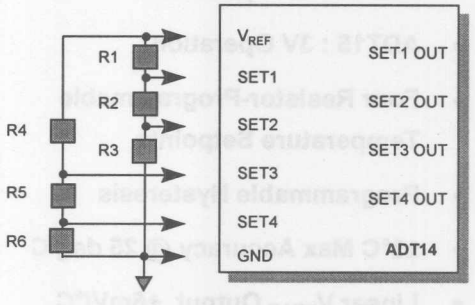
- ADT14 : 5V Operation
- ADT15 : 3V Operation
- Four Resistor-Programmable Temperature Setpoints
- Programmable Hysteresis
- ±3°C Max Accuracy @ 25 deg C
- Linear V_{PTAT} Output, +5mV/°C
- 5 mA Open-Collector Outputs



11 - 7

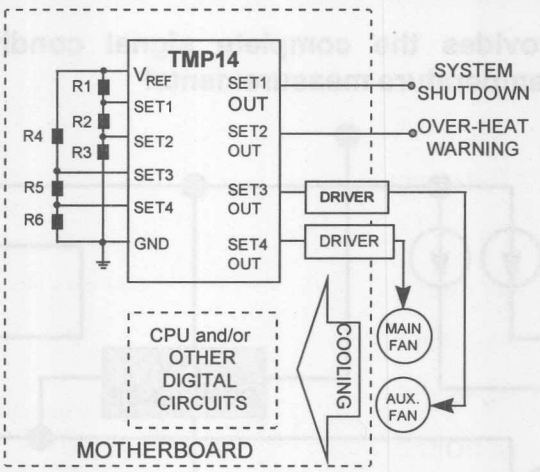
ADT14, ADT15 (con't)

- Internal 2.5V Reference
- Low Power :
  - 500uA Max Supply Current
  - 10uA in Shutdown
- Specified -40°C to +125°C
- 16 Pin DIP and SOIC Packages



11 - 8

Example of Cooling Monitor in Server Application:

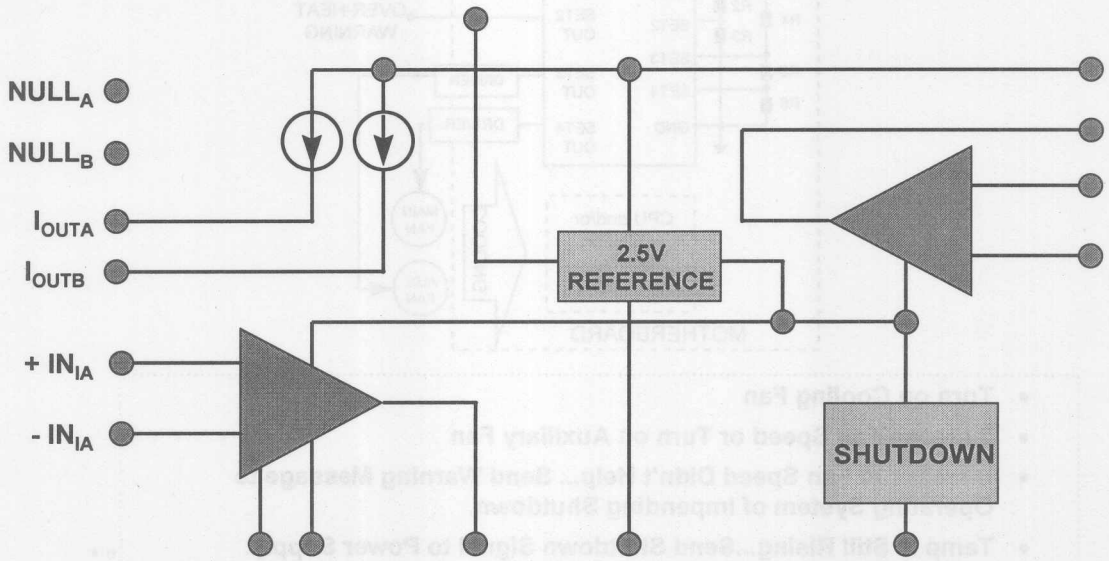


- **Turn on Cooling Fan**
- **Increase Fan Speed or Turn on Auxiliary Fan**
- **Increase in Fan Speed Didn't Help... Send Warning Message to Operating System of Impending Shutdown.**
- **Temp Is Still Rising...Send Shutdown Signal to Power Supply.**

11-9

ADT70 Platinum RTD Conditioning Circuit

The ADT70 provides the complete signal conditioning solution for Platinum RTD temperature measurements!



11 - 10

ADT70- Key Specs and Features

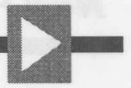
- **Complete, PRTD Signal Conditioning Solution :**
  - **Matched 1mA (nominal) RTD Current Sources**
  - **Rail-Rail Output *Instrumentation Amplifier***
  - **Uncommited Rail-Rail Output Operational Amplifier**
  - **On-Board 2.5V Reference**
- **Optimized for 1k ohm Platinum RTD**
- **Measures RTD Temperatures from -50 deg C to 500 deg C**
- **Extended Performance from -200 deg C to 1000 deg C**

ADT70- Key Specs and Features (con't)

- **High Accuracy :**
  - **± 0.1 deg C typ Error over RTD Range**
  - **± 15 ppm/deg C Tempco**
- **Single +5V or Dual ± 5V Operation**
- **Low Current Consumption :**
  - **3 mA Normal**
  - **10 uA Max in SHUTDOWN**
- **-40 deg C to +125 deg C Operating Temp Range**
- **20 Pin DIP and SOIC Packages**

11 - 12

Monolithic Accelerometers

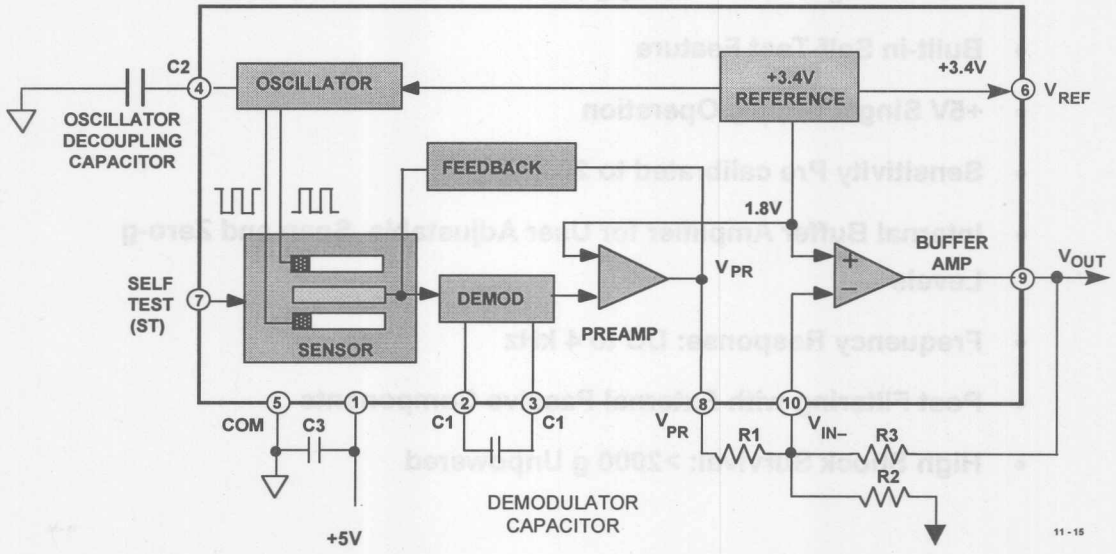


Where Are Accelerometers Used?

- **Measurement of Gravity to Determine Orientation:**
  - **Tilt and Inclination**
  - **Position in 2 and 3 Dimensional Space**
- **Inertial Measurement of Velocity and Position:**
  - **Acceleration Single Integrated for Velocity**
  - **Acceleration Double Integrated for Position**
- **Vibration and Shock Measurement:**
  - **Measuring Vibration for Machine Health**
  - **Motion and Shock Detection**

ADXL05
Monolithic ± 5g Accelerometer With Signal Conditioning

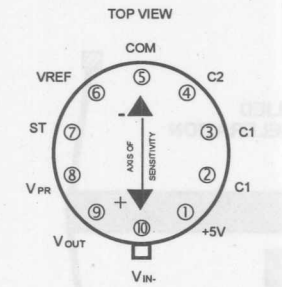
The ADXL05 is a complete acceleration measurement system in a single monolithic IC!



ADXL05 - Key Specs and Features

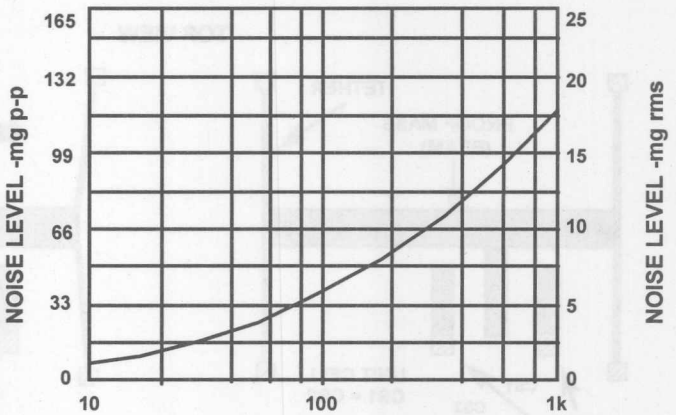
- **Full-Scale Measurement Range: ±5g**
- **Low Voltage Noise of 500µg per root Hz**
- **Built-in Self-Test Feature**
- **+5V Single Supply Operation**
- **Sensitivity Pre calibrated to 200mV/g**
- **Internal Buffer Amplifier for User Adjustable Span and Zero-g Levels**
- **Frequency Response: DC to 4 kHz**
- **Post Filtering with External Passive Components**
- **High Shock Survival: >2000 g Unpowered**

ADXL05 - Noise Level vs Bandwidth



NOTE: AXIS OF SENSITIVITY
IS INPLANE OF PIN 5 TO TAB

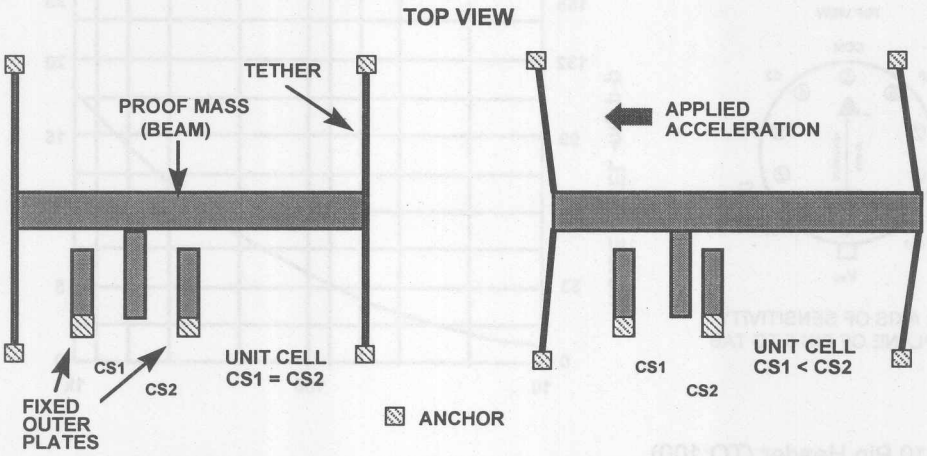
ADXL05 10 Pin Header (TO:100)
Connection Diagram



ADXL05 Noise Level vs 3 dB Bandwidth

11 - 17

How Does the ADXL05 Work?

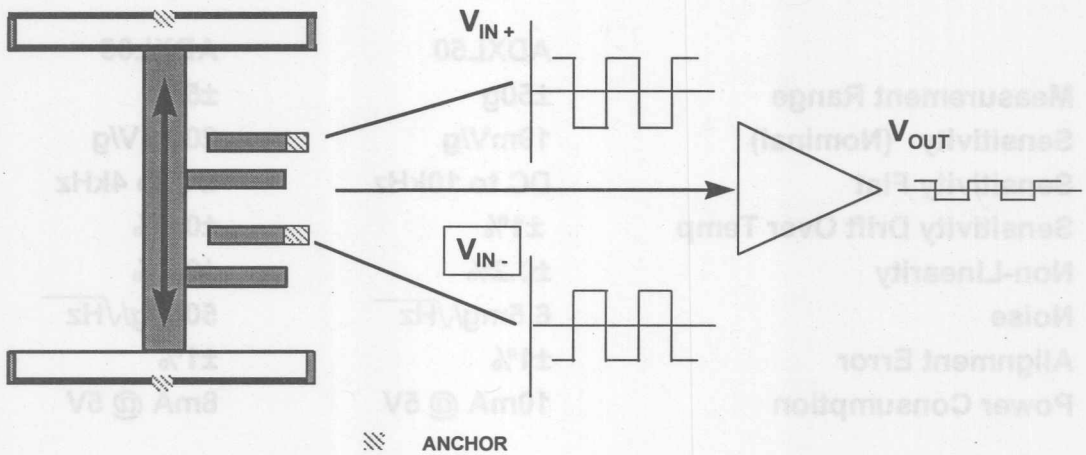


ADXL05 SENSOR AT REST

RESPONDING TO AN APPLIED ACCELERATION

11 - 18

How Does the ADXL05 Work (con't)?



Drive Signals are 180 Degrees Out of Phase. When the Differential Capacitors are Unequal, There is a Signal Out of the Sensor which is Proportional to the Force on the Beam.

11 - 19

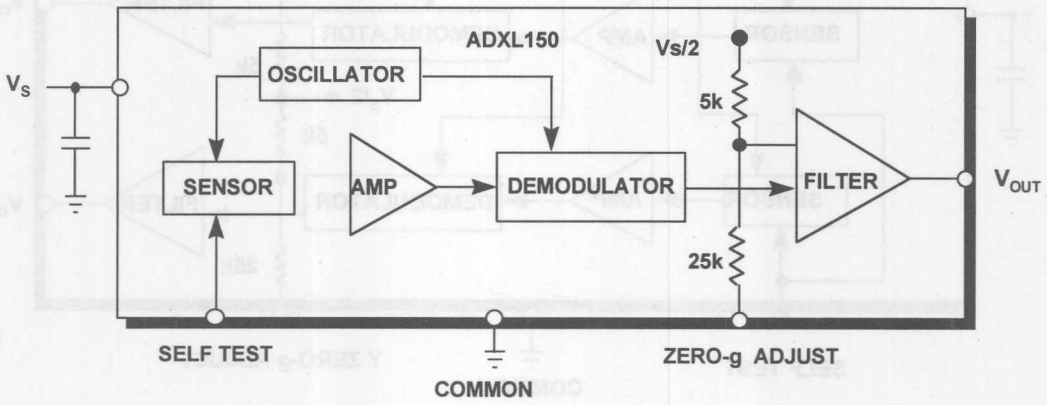
A Comparison of the ADXL05 to the ADXL50...

	ADXL50	ADXL05
• Measurement Range	±50g	±5g
• Sensitivity (Nominal)	19mV/g	200mV/g
• Sensitivity Flat	DC to 10kHz	DC to 4kHz
• Sensitivity Drift Over Temp	±1%	±0.5%
• Non-Linearity	±0.2%	±0.2%
• Noise	6.5mg/$\sqrt{Hz}$	500µg/$\sqrt{Hz}$
• Alignment Error	±1%	±1%
• Power Consumption	10mA @ 5V	8mA @ 5V

11 - 20

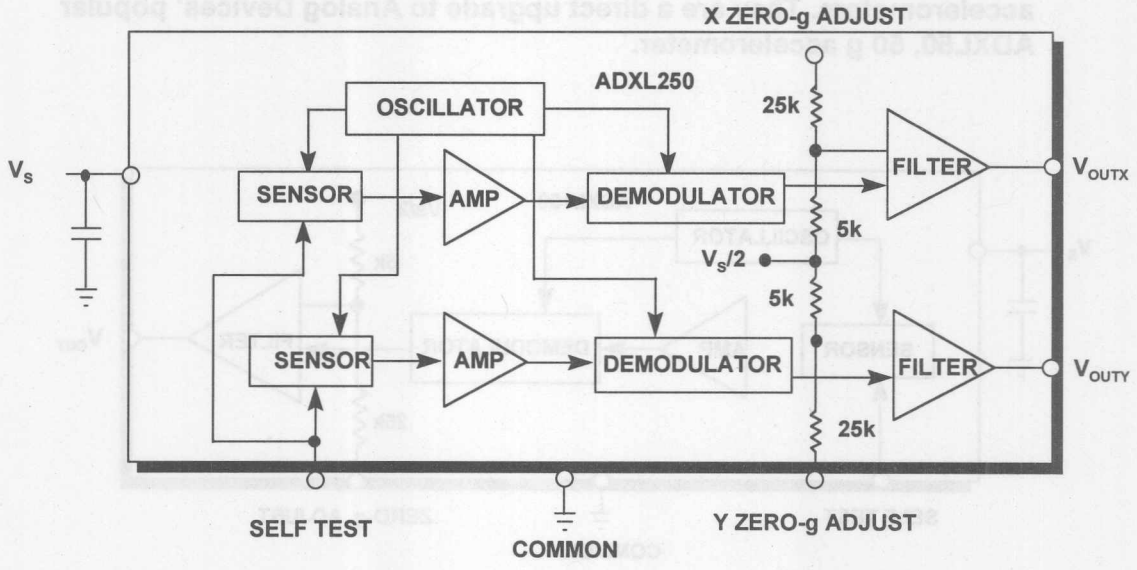
ADXL150 and ADXL250
Low Power, Low Noise, Single/Dual Axis Accelerometers

The ADXL150 and ADXL250 are monolithic, single and dual axis accelerometers. They are a direct upgrade to Analog Devices' popular ADXL50, 50 g accelerometer.



11 - 21

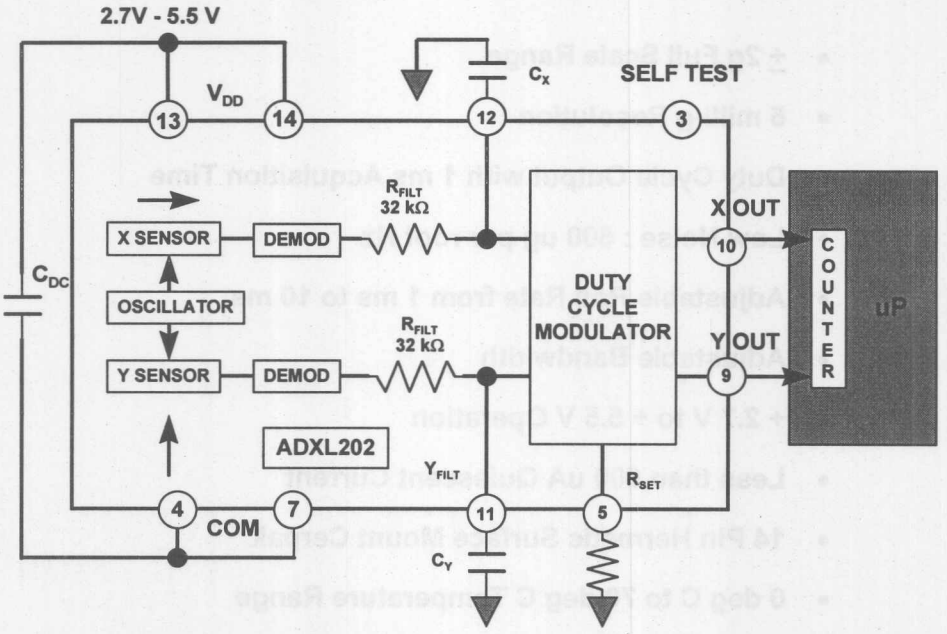
ADXL250 - Simplified Diagram



11 - 22

Preliminary Information

ADXL202
Low Cost, Dual Axis Accelerometer



11 - 23

ADXL202 - Key Specs and Features

- ± 2g Full Scale Range
- 5 milli-g Resolution
- Duty Cycle Output with 1 ms Acquisition Time
- Low Noise : 500 ug per root Hz
- Adjustable Rep Rate from 1 ms to 10 ms
- Adjustable Bandwidth
- + 2.7 V to + 5.5 V Operation
- Less than 600 uA Quiescent Current
- 14 Pin Hermetic Surface Mount Cerpak
- 0 deg C to 70 deg C Temperature Range

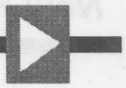
11 - 24

Section 12
Video Graphics Products

Digital Video Encoders

Digital Video Decoders

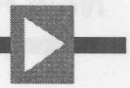
D/A Converters for Video Graphics



Digital Video Encoders

What Are Digital Video Encoders?

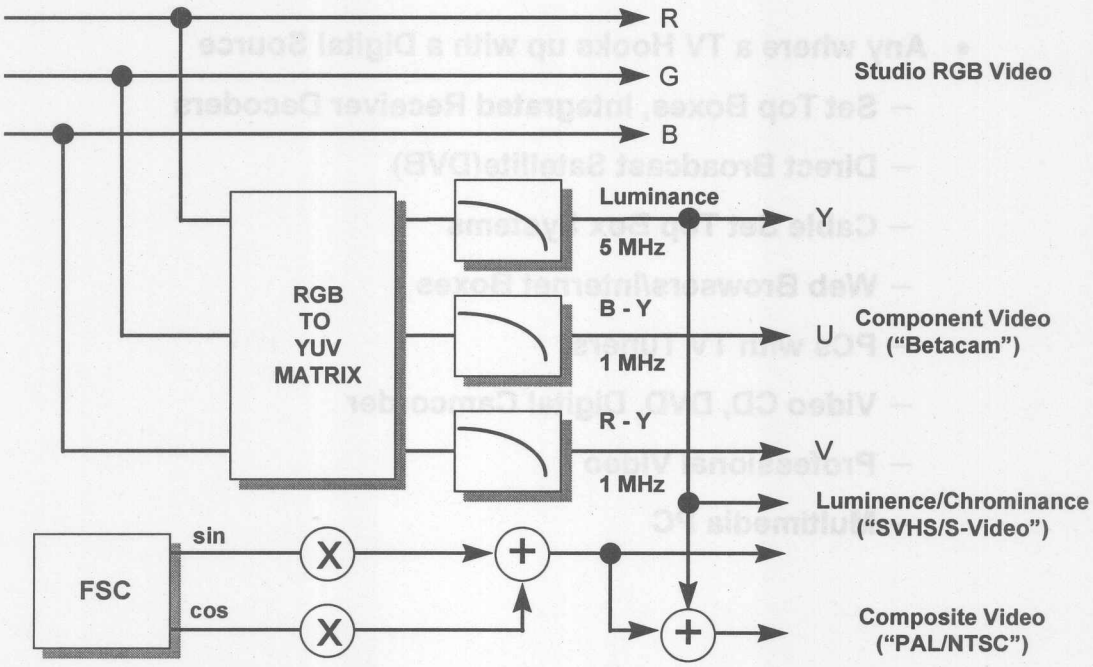
A *Digital Video Encoder* converts Digital Component Video Data (CCIR-601 4:2:2) into a standard analog baseband television signal compatible with NTSC, PAL B/D/G/H/I, PAL M or PAL N. In addition to the Composite output signal, there is often the facility to output S-VHS Y/C, RGB or YUV Video.

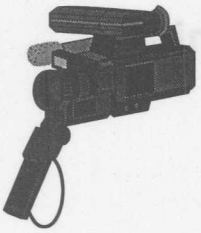


Where are (Digital) Video Encoders Used?

- **Any where a TV Hooks up with a Digital Source**
  - **Set Top Boxes, Integrated Receiver Decoders**
  - **Direct Broadcast Satellite(DVB)**
  - **Cable Set Top Box Systems**
  - **Web Browsers/Internet Boxes**
  - **PCs with TV Tuners**
  - **Video CD, DVD, Digital Camcorder**
  - **Professional Video**
  - **Multimedia PC**

Video Signal Formats...





Video Formats (con't)

- **Luminance = 0.299R + 0.578G + 0.114B**
- **U = 0.492 (B-Y)**
- **V = 0.877 (R-Y)**
- **CHROMA = U sin (wt) + V cos(wt) = A sin (wt + O)**
- **A = Saturation, O = Hue**
- **3.58 MHz = NTSC**
- **4.43 MHz = PAL**

Digital Video Encoder Product Family

- ***ADV7175A, ADV7176A...***
  - **10 Bit, High Quality Video Encoders with/without MACROVISION™**
- ***ADV7177, ADV7178...***
  - **9 Bit, Lower Cost Versions of ADV7175A and ADV7176A**
- ***ADV7174...***
  - **Similar to ADV7176A, No Teletext Insertion, Adds OSD (On Screen Display)**
- **ADV7170, ADV7171...**
  - **Next Generation ADV7175A, ADV7176A, Adds CGMS-A and WSS (Wide Screen Signalling)**

What is MacroVision?

- **"Pay-per-View" Copy Protection System**
- **Prevents Users from Making Unauthorized Copies of Digitally-Transmitted Pay Per View Videos using a VCR (Rev 6.0)**
- **Rev 7.1 Set for NTSC/PAL**
- **License Required to Purchase ADV7175A**

ADV7175A and ADV7176A

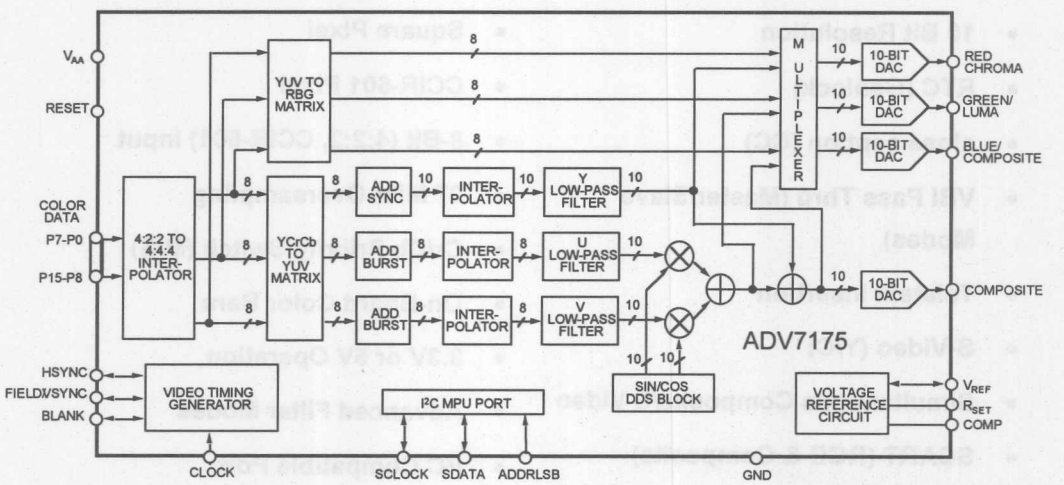
- **The ADV7175A Has the Additional Feature of the Macrovision (Revision 7.1) Anticopy Algorithm.**

- **ADV7176A Fully Backward Compatible (software, hardware and pinout) with ADV7176**

- **ADV7175A Hardware and Pinout Compatible, but Requires Programming Edits for Rev 6.1 or Rev 7.01**

12 - 10

ADV7175A and ADV7176A - Simplified Diagram



12 - 11

ADV7175A, ADV7176A - Key Specs and Features

- 4 D/A Converters
- 10 Bit Resolution
- RTC (Genlock)
- close caption (CC)
- VBI Pass Thru (Master/Slave Modes)
- Teletext Insertion
- S-Video (Y/C)
- Simultaneous Composite/S Video
- SCART (RGB & Composite)
- YUV Output
- Square Pixel
- CCIR-601 Pixel
- 8-Bit (4:2:2, CCIR-601) Input
- 27 MHz Oversampling
- Cr/Cb Priority Switch (M/S)
- On-Board Color Bars
- 3.3V or 5V Operation
- Advanced Filter Modes
- I^2C Compatible Port

12 - 12

ADV7177 and ADV7178

The ADV7177 and ADV7178 are lower cost versions of the ADV7175A and ADV7176A, respectively

Includes...

- **3 D/A Converters**
- **9 Bit Resolution**
- **On Screen Display (OSD) - ADV7177, Only**
- **13.5 MHz Clock Out Support**
- **Crystal Output**

Does Not Include...

- **RTC Genlock Feature**
- **Teletext Insertion**
- **SCART (RGB & Composite)**
- **YUV Output**

12 - 13

ADV7174

- **Similar to ADV7176A**

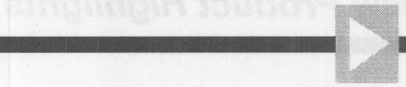
Includes...

- **On-Screen Display (OSD)**

Does Not Include...

- **Teletext Insertion**

12 - 14



Digital Video Decoders

What Are Digital Video Decoders?

A *Digital Video Decoder* converts CVBS, S-Video and YUV analog baseband television signals into Digital CCIR-601 4:2:2 Component Video compatible with NTSC, PAL B/D/G/H/I, PAL M or PAL N.

ADV7185
Video Decoder with Comb Filtering and H,V Scaling

The ADV7185 is an integrated Video Decoder that recognises analog baseband NTSC or PAL television signals and converts to Digital 4::2:2 or 4:1:1 Component Video Data in 16-bit CCIR601, 8-bit CCIR656 or extended 10-bit CCIR656 format.

There is the facility to input 6 Composite or 3 S-VHS Y/C Video signals or a combination of the two.

The ADV7185 modes are set up over a serial bi-directional 2 wire interface (I^2C Compatible).

12 - 17

ADV7185 - Key Specs and Features

- 10-Bit A/D Converters with 57dB SNR
- Single 27 MHz Clock Required
- Real Time Horizontal and Vertical Scaling
- Luma and Chroma Comb Filtering
- Automatic NTSC/PAL Identification
- 0.5V to 2.0V pk-pk Input Range
- Differential Gain < 1%
- Differential Phase < 1 Degree
- Programmable or Automatic Gain Control
- Programmable Peak White, Hue, Brightness, Saturation and Contrast

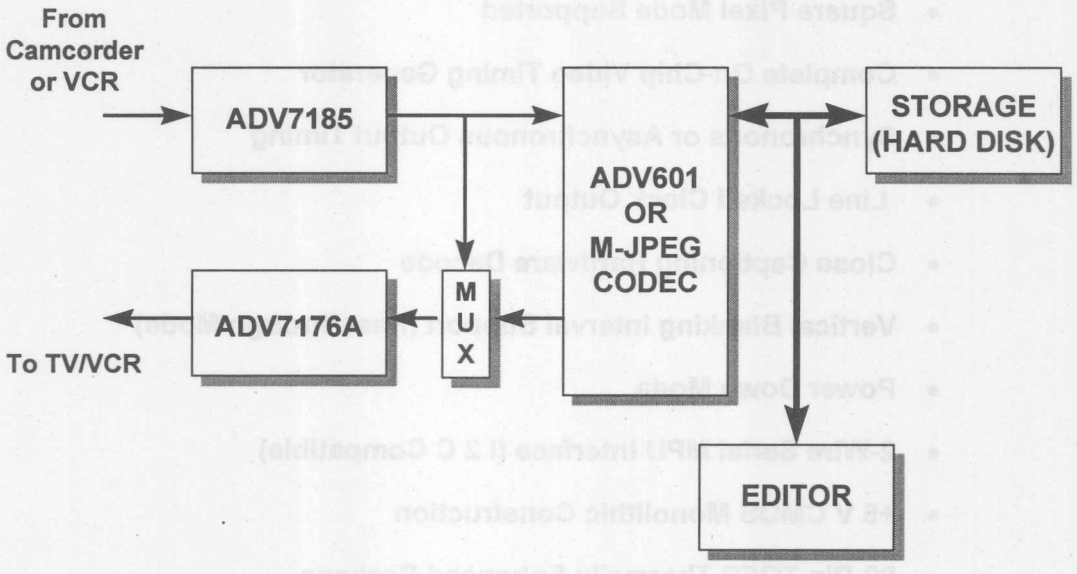
12 - 18

ADV7185 - Key Specs and Features (con't)

- Square Pixel Mode Supported
- Complete On-Chip Video Timing Generator
- Synchronous or Asynchronous Output Timing
- Line Locked Clock Output
- Close Captioning Hardware Decode
- Vertical Blanking Interval Support (Passthrough Mode)
- Power Down Mode
- 2-Wire Serial MPU Interface (I 2 C Compatible)
- +5 V CMOS Monolithic Construction
- 80-Pin TQFP Thermally Enhanced Package

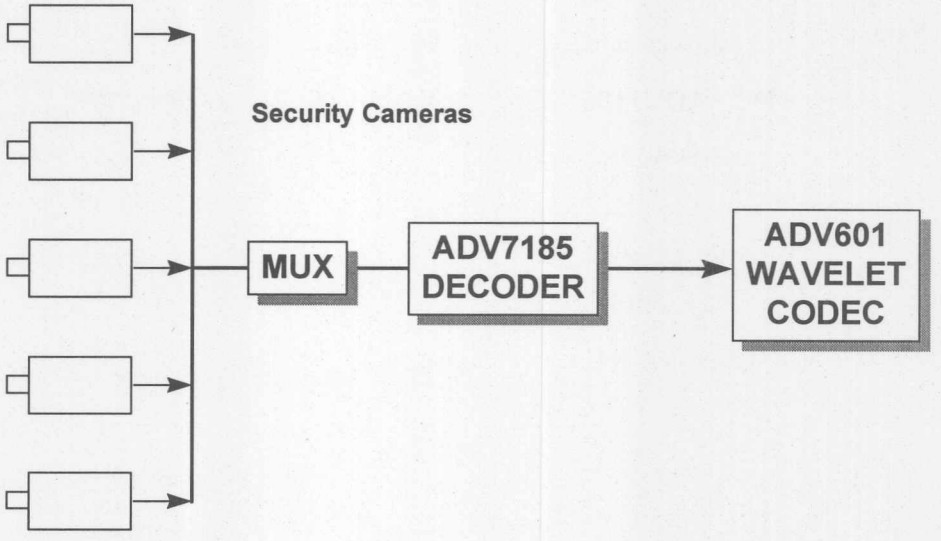
12 - 19

ADV7185 - Video Editing

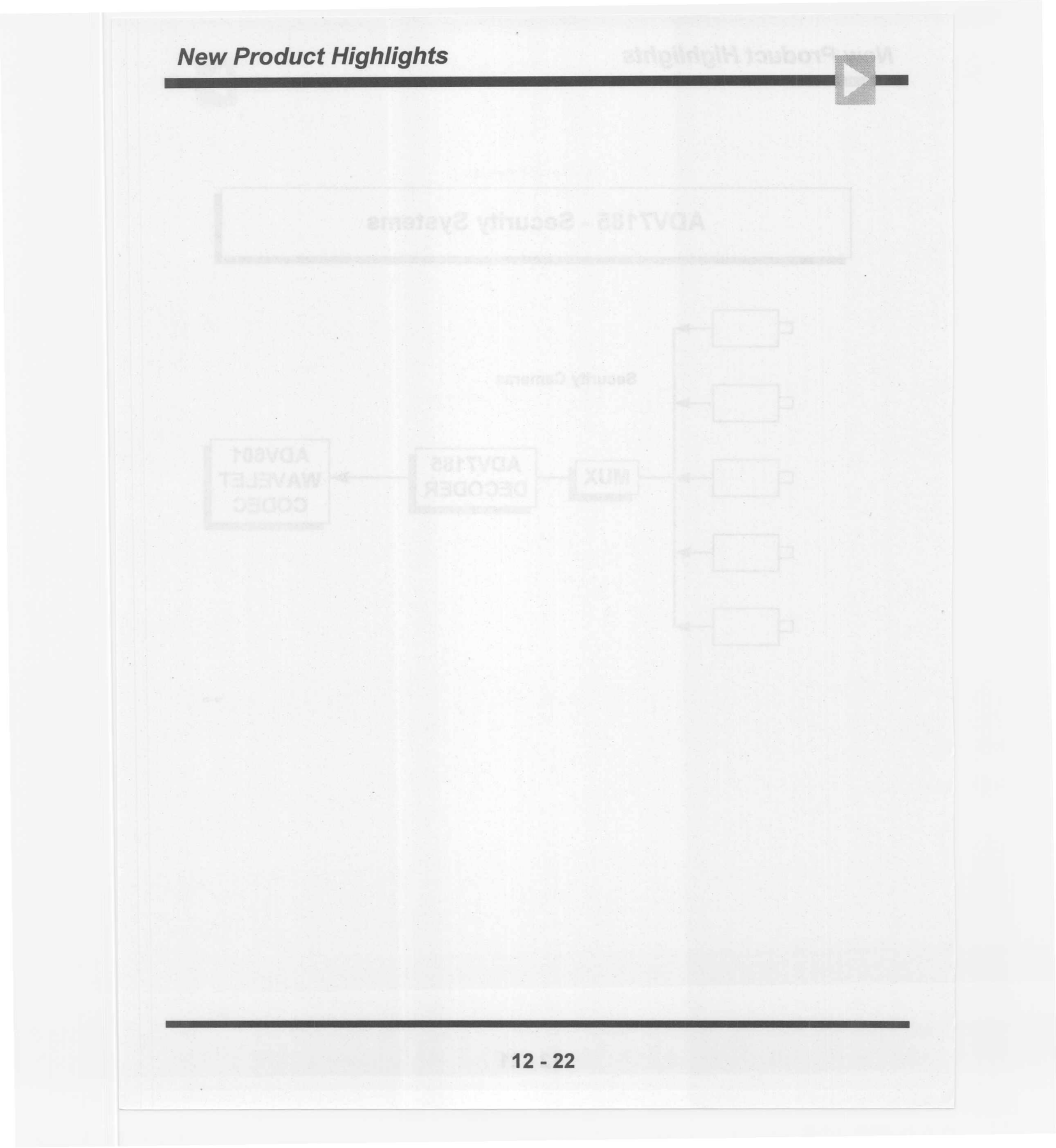


12 - 20

ADV7185 - Security Systems



12 - 21



D/A Converters for Video Graphics

ADV7123 and ADV7127
10-Bit, Single/Triple Video D/A Converters

The ADV7123 and ADV7127 are 10 Bit D/A Converters capable of generating RGB video output signals compatible with RS-343A and RS-170 broadcast standards.

- 140 MSPS Throughput Rates
- -48dB Spurious-Free Dynamic Range
- RS-343A/RS-170 Compatible Output
- TTL Compatible Inputs
- Internal Reference : ± 2%
- +5 V CMOS Monolithic Construction
- Low Power Dissipation
- Low Power Standby Mode
- 48-Pin TQFP Package
- Industrial Temperature Range : -40 deg C to +85 deg C

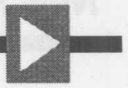
12 - 24

ADV7129
8 Bit, 360 MHz True-Color Video DAC with On-Board PLL

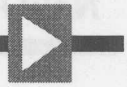
The ADV7129 is a complete analog output, Video DAC on a single CMOS monolithic chip. The part is specifically designed for use in the highest resolution graphics and imaging systems

- 360 MHz, 24-Bit True-Color Operation
- 192-Bit Pixel Port allows 2048 x 2048 x 24 screen resolution
- 8:1 Multiplexing
- On-board PLL CLK Generator
- RS-343A/RS-170 Compatible Analog Outputs
- TTL Compatible Digital Inputs
- Internal Voltage Reference
- Standard 8-Bit MPU I/O Interface
- DAC-DAC Matching: Typ 2%, adjustable to 0.02%
- +5 V CMOS Monolithic Construction
- 304-Pin PQFP Package

12 - 25



Section 13
Motor Control Products



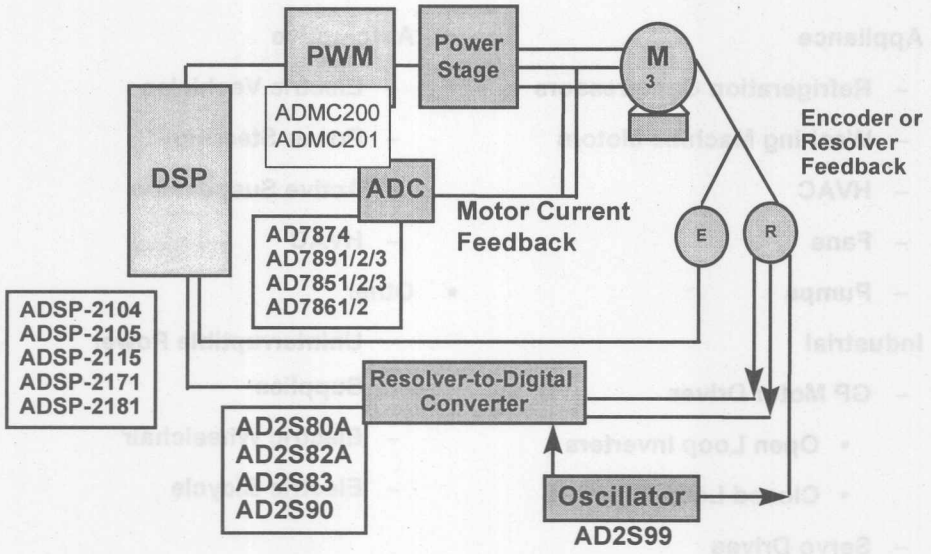
Why DSP In Motor Control?

- Increased Performance With Higher Processing Power
- Complex Mathematical Algorithms
  - Variable Speed Control
  - Vector Calculations - Park/Clark
  - Sensorless Control
  - Filtering
  - Noise & Vibration Reduction
  - Power Factor Correction
- Real-Time Processing
- Flexibility
- Trend to Digital Control
- Integrated (Single Chip) Solution

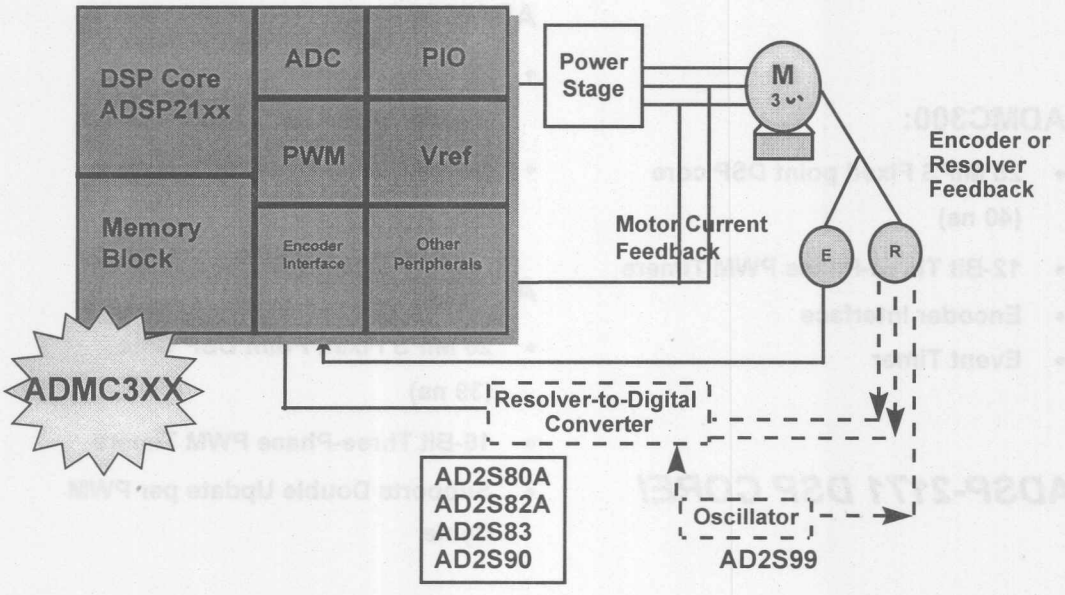
Applications for DSP Based Motor Control

- Appliance
  - Refrigeration Compressors
  - Washing Machine Motors
  - HVAC
  - Fans
  - Pumps
- Industrial
  - GP Motor Drives
    - Open Loop Inverters
    - Closed Loop Inverters
  - Servo Drives
- Automotive
  - Electric Vechicles
  - Power Steering
  - Active Suspension
  - HVAC
- Other
  - Uninterruptible Power Supplies
  - Electric Wheelchair
  - Electric Bicycle

Analog & Digital IC Motor Control Signal Chain



Analog & Digital IC Motor Control Signal Chain - Integration



ADMC300,ADMC330, ADMC331 - Key Model Differences

ADMC300:

- 25 MIPS Fixed point DSP core (40 ns)
- 12-Bit Three-Phase PWM Timers
- Encoder Interface
- Event Timer

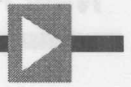
ADSP-2171 DSP CORE!

ADMC330:

- 20 MIPS Fixed point DSP core (50 ns)
- 12-Bit Three-Phase PWM Timers

ADMC331:

- 26 MIPS Fixed Point DSP Core (39 ns)
- 16-Bit Three-Phase PWM Timers
- Supports Double Update per PWM Cycle



ADMC300, ADMC330, ADMC331 - Key Differences (con't)

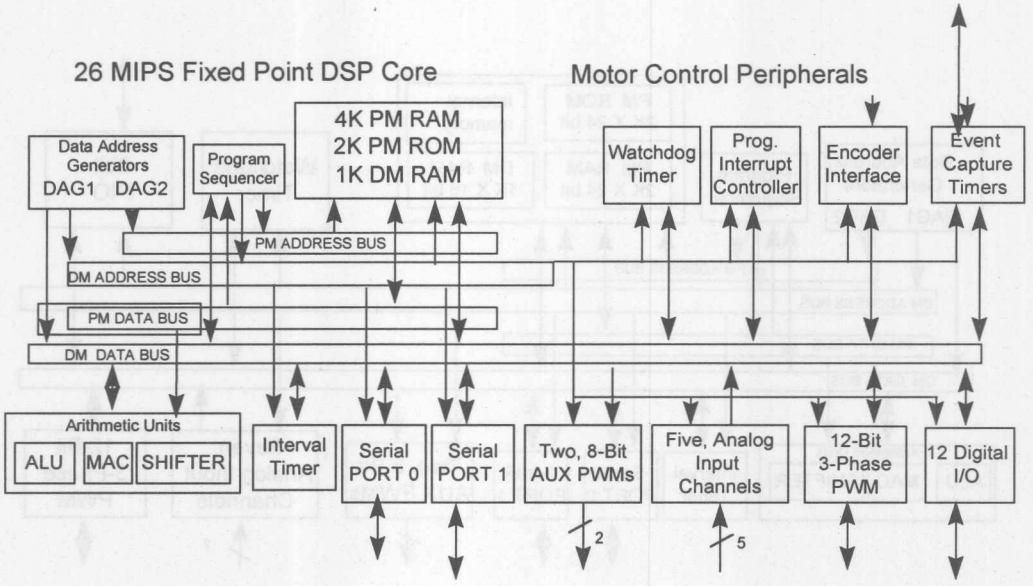
	ADMC300	ADMC331	ADMC330
MIPS	25	20	26
24 bit Program Memory RAM	4k	2k	2k
24 bit Program Memory ROM	2k	2k	2k
24 bit Data Memory RAM	1k	1k	1k
Analog Inputs	5	7	7
Programmable I/O Pins	12	8	24

ADMC300, ADMC330, ADMC331 - Key Specs and Features

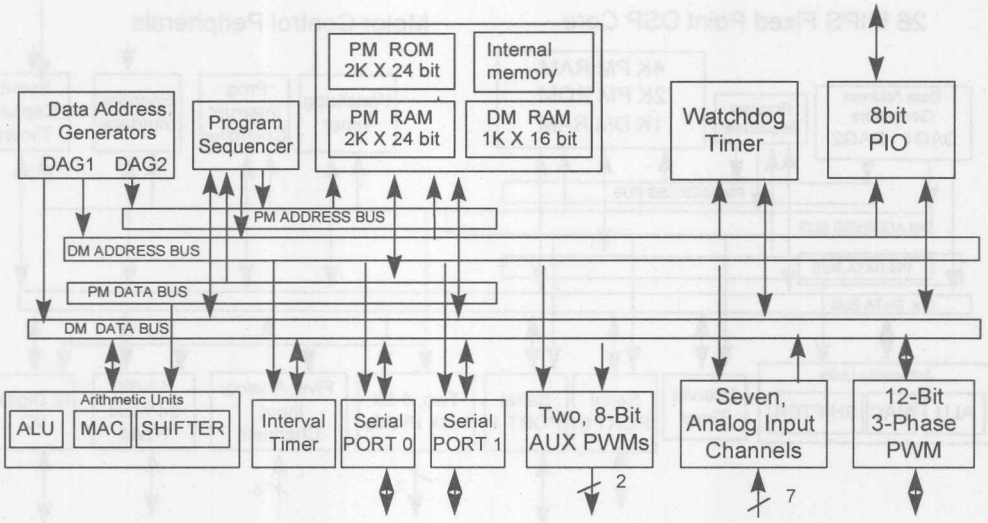
- 2 (Variable Frequency)[1] Auxiliary PWM Timers
- Watchdog Timer
- Supports Control of AC Induction & Permanent Magnet Synchronous and (Switched Reluctance) [1] Motors
- Hardware PWM Trip for Protection, Safety, & Reliability
- 80 Pin TQFP (Thin Quad Flat Pack) Package
- - 40 deg C to + 85 deg C Operation

Note 1 : ( ) apply to ADMC331, also

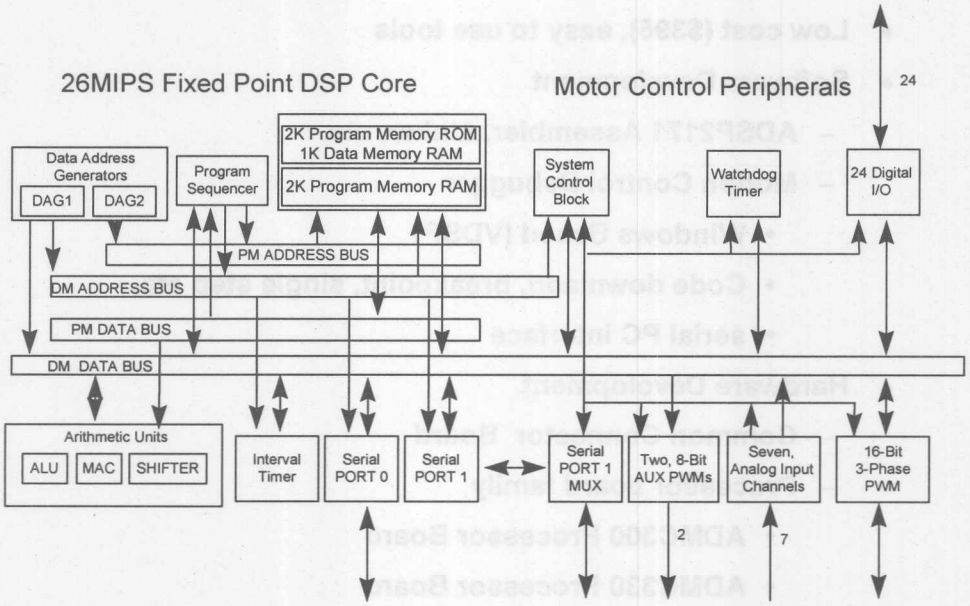
ADMC300 - Servo DSP Motor Controller



ADMC330 - DSP Motor Controller



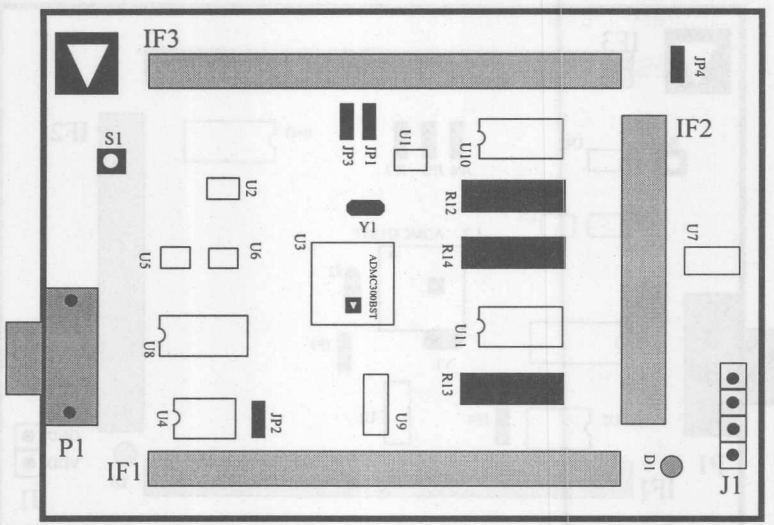
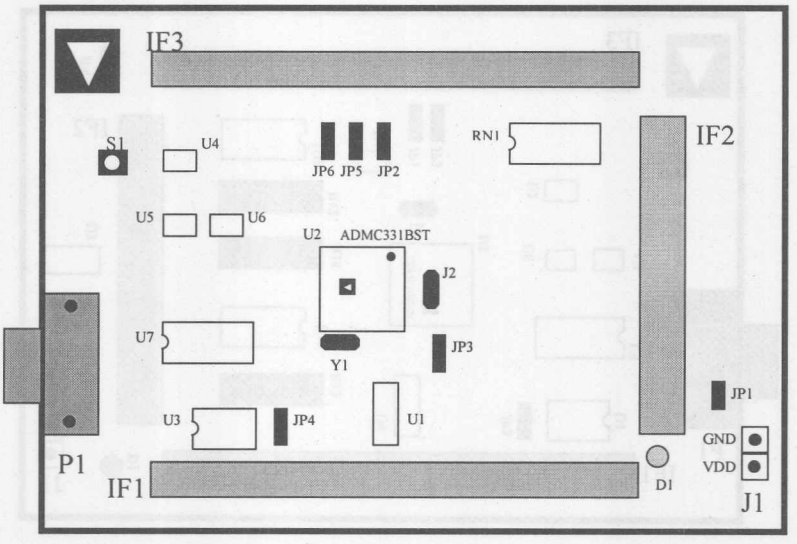
ADMC331 - DSP Motor Controller



Motor Control Development Tools

- Low cost ($395), easy to use tools
- Software Development
  - ADSP2171 Assembler, Linker, etc.
  - Motion Control Debugger
    - Windows Based (VDSP)
    - Code downlaod, breakpoint, single step etc.
    - serial PC interface
- Hardware Development
  - Common Connector Board
  - Processor board family
    - ADMC300 Processor Board
    - ADMC330 Processor Board
    - ADMC331 Processor Board

ADMC300 Evaluation Board



ADMC331 Evaluation Board